SCIENCE

FRIDAY, OCTOBER 4, 1912

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THE ALLEGHENY OBSERVATORY IN ITS RELATION TO ASTRONOMY[1]

WHEN I last visited the Allegheny Observatory, in 1869, I found very different conditions from those that prevail to-day. As a boy, I had learned that Pittsburgh was at the junction of the Allegheny and Monongahela Rivers, and I was glad to verify it by actual inspection from the door of the observatory. To-day these rivers are not in sight. The little thirteen-inch telescope appears to have attained dimensions and to have acquired appliances beyond our dreams in those days. In one respect is the observatory unchanged. I find a young and enthusiastic director, full of new ideas and, I hope, aiming to make this observatory the greatest in the world. My good friend Langley was then thirty-four years old. His work on the sun, continued through his life, was in its infancy. He tried to persuade us that the smoke hanging over Pittsburgh was especially advantageous for his line of work, since it cut off the irregularities due to the heat of the sun when the sky is clear. Within limits, this is true.

The early history of the Allegheny Observatory is unique, and in some respects stormy. The first director became obsessed with the idea that the telescope must be preserved, but not used. This view he maintained with the aid of a shotgun. He became insane, and wrote a poem. Far be it from me to suggest any connection between these two facts. In this poem, he predicted that the object glass of the telescope would be stolen. Strangely enough,

[1] An address delivered at the dedication of the new Allegheny Observatory, August 28, 1912.

this prediction came true, and more strangely still, in spite of this prediction, it was proved conclusively that he had nothing to do with the theft. The object glass was carried off and held for ransom by persons who greatly overestimated its value. Langley gave a most interesting account of his experiences with the thieves. He was supported by the trustees of the observatory in maintaining that not a cent should be paid unless the thief could be punished, otherwise no large lens in the country would be safe. Finally he met the thief by appointment, one evening, and as they walked up and down a wooded path, the thief remarked, "You are a gentleman, and I am a gentleman; we must trust one another." Finally, the lens was returned uninjured, without ransom.

Langley's invention of the bolometer opened a line of research which has continued to the present time. He displayed consummate skill and ingenuity in its development, and extraordinary patience in overcoming the numerous difficulties which presented themselves. Even in those early days he was deeply interested in the problems of artificial flight. We were often together in the woods or mountains and whenever he saw a hawk, or other large bird soaring, he would stop and watch it, saying, "Some day we shall do that." His discovery of the internal work of the wind was one whose importance does not seem yet to be appreciated. It still seems possible that practical results may be obtained from it. The credit for the invention of the aeroplane is due, in a large measure, to him, and he was bitterly hurt at his treatment by the public press after the destruction of his first aeroplane. Later experience shows that another trial might have proved an entire success.

My acquaintance with his successor, Keeler, was much less intimate, but close enough to recognize his charming disposition and rare talents. Astronomy suffered a heavy loss in his early death. In his work here, and on Mount Hamilton, he has left among others two researches with the spectroscope which have become classical. First, the brilliant proof that the rings of Saturn are composed of minute portions revolving independently around the planet. Secondly, a determination of the motion in the line of sight of gaseous nebulæ. This appears to be the best solution yet found of this problem. It is remarkable that no one has repeated and continued it. Keeler measured only ten of the two hundred nebulæ now known to be gaseous.

The work of Wadsworth was more in preparation than in obtaining results, while that of Acting-Director Brashear has been overshadowed by an enthusiasm which has not only rendered this new observatory possible, but will be of the greatest value to it in the future, and inspires us all to renewed efforts by his unflagging zeal.

The present director, Professor Schlesinger, can give you a better description of his work than I can. But as I fear that he may not do justice to its quality, a brief account of it may not be out of place here. Half a century ago, the character of the work done by astronomers was very different from that undertaken at the present time. It then consisted almost entirely in a study of the positions and motions of the heavenly bodies. In fact, if an astronomer had a large equatorial telescope, he generally devoted himself to measuring the relative positions of the components of double stars, and if he had a meridian circle, he measured the positions of large numbers of stars, and determined day by day the exact time. At the larger observatories the position of the moon and other objects in the solar system were determined. A few far-seeing men of genius

like Argelander, the Herschels and the Bonds undertook other lines of work, but the last half of the nineteenth century saw the birth of a new science, astrophysics, which relates to other properties of the stars, such as their brightness, size, color and spectrum. Astronomy may, therefore, be divided into two classes, the astronomy of position and astrophysics, which Langley called the old and the new astronomy. Two years ago, forty of the leading astronomers of Europe visited this country to attend the meeting of the Solar Union, at the Mount Wilson Observatory, in California. On the way, many of them attended the meeting in Cambridge of the Astronomical and Astrophysical Society of America, now in session here. One of the most eminent of these astronomers, while complimenting us highly on American work in astrophysics, pointed out that of the forty-eight papers read at the meeting, but one related to astronomy of position. You are fortunate in having as director of the Allegheny Observatory an astronomer who has distinguished himself in both departments of the science. A very interesting problem in astronomy of position is a curious motion of the earth by which the latitude of any given point is continually changing by a small amount. If we found the average position of the North Pole and built a circular fence around it seventy feet in diameter, the pole would wander about the enclosed space, describing an irregular spiral, but never going outside of it. Last year the pole appears to have been nearer the fence than at any time during the last quarter of a century, or since the discovery of this motion. A number of stations are now maintained by the International Geodetic Association, at which continuous measures are made of the position of the pole. The accuracy of these measures is such that its position is known within one or two feet. For four years Professor Schlesinger took part in these measures at the station in Ukiah, California. He thus familiarized himself with some of the most accurate methods of measurement of position known.

One of the most important problems before astronomers at the present time is to determine the distances of the stars. The only direct method of finding the distance of an inaccessible object is to measure the change in its apparent position as seen from different points. Fortunately, we can apply this method to the stars, since the earth is more than ninety million miles from the sun, and by its revolution around the latter its position is changed by nearly two hundred million miles. It is quite impossible for the mind of man to conceive of such a distance, but vast as it is, it is almost inappreciable compared with the distance of the stars. Few of them are less than a million times as distant as the sun, and the greater portion of them are probably thousands of times as distant as the nearest. The apparent change in position of the nearest star, as the earth moves two hundred million miles, would equal the height of a man at a distance of two hundred miles. In other words, the problem is like measuring the height of a man two hundred miles away. Various methods have been tried, but the most accurate of all appears to be that employed by Professor Schlesinger. He finds the height of the man with an uncertainty of only one inch! The method he used, when he was at the Yerkes Observatory, consisted in taking photographs with the forty-inch refractor of that institution, the largest telescope of its kind in the world. By using plates sensitive to the yellow rays, he obtained very minute images of the stars, which could be measured with the greatest accuracy. The results for a large number of

stars measured in this way indicated a probable error of only a hundredth of a second of arc.

The criticism that, in America, we were not doing our share of the study of the position of the stars, seemed to be a just one. Accordingly, as president of the Astronomical and Astrophysical Society of America, I appointed a committee to remedy this defect as far as possible, and selected Professor Schlesinger as its chairman. Some of the results so far obtained will be announced at the present meeting of the society. Besides the work already described, admirable results in astrophysics have recently been obtained at the Allegheny Observatory by the director, in measuring the motion of the stars in the line of sight, a problem now receiving more attention than any other in many of the principal observatories of the world. Of this problem, it is sufficient to say that to obtain results of the accuracy attained elsewhere, it is necessary to have a telescope of the largest size, a spectroscope of the most approved form, and measures and reductions of the photographs of the greatest possible accuracy.

You will thus see that, as already stated, you have secured an astronomer and placed him in charge of your observatory, who has shown great skill and efficiency in both the old and the new departments of astronomical research. You have before you a beautiful and suitable building and an equipment of instruments of the highest grade. All of those conditions are most favorable, but the future success will now depend largely on you. Allegheny is doubtless a very different place intellectually from what it was when Langley was here, but one of his principal sources of discouragement was the lack of interest in his work, and a failure to appreciate his success by his friends, with a few notable exceptions. I hope that you will follow the work of the Allegheny Observatory closely, and I am sure that you will find the results of interest and value. A large force of observers and computers is needed to derive the best results from an equipment such as is collected here. The number of officers at several of the largest observatories is thirty or forty, and such a force is required to complete in a reasonable time some of the great problems which now form the most important contribution which can be made to astronomy. For example, suppose that an astronomer has developed by long and careful study the best method of attaining a certain result with an instrument costing many thousands of dollars. He can almost always instruct a younger and less able man than himself to repeat his work on other stars. A research can thus be extended, at small additional expense, to hundreds or perhaps thousands of stars, until the entire available time of the instrument is occupied. In visual observations of the stars, this time is greatly restricted by clouds, twilight, moonlight and other causes, while a photograph exposed for a few minutes may furnish material for weeks of study. After a photograph is measured, there is often a long and laborious computation to be undertaken, which can be carried on by unskilled computers after they have been taught the exact method. The results are of no value unless they are made known to the world by publication. This involves laborious copying, arranging material in suitable form, reading of proof and other work involved in publication, in addition to the actual cost of printing. It is evidently very poor economy to establish an extensive plant, and then fail to work it to its full capacity. A steamer which should be idle for ten or eleven months every year would prove a very poor investment. In

astronomy, increasing returns constitute the rule and not the exception, while the methods of securing the maximum efficiency by the principles of "scientific management" may be as successful in an observatory as in an industrial establishment.

An illustration of my meaning is presented by the photometric work at Harvard. In 1879 an instrument was constructed for measuring the light of the bright stars, with telescopes two inches in diameter. With this, during the next three years, a hundred thousand measures were made of four thousand stars, mainly visible to the naked eye. When people asked me if we had the largest telescope in the world, I would answer, "No, but we have the smallest that is doing useful work." Encouraged by the success attained, a second similar instrument was constructed with telescopes of four inches aperture. Since 1882 over a million measures have been made of nearly fifty thousand stars. Three times it has been sent to South America to measure the southern stars, and it is now on its way to South Africa, loaned to an English astronomer. To study still fainter stars a twelve-inch telescope has been mounted, and with this since 1892 I have made seven hundred thousand measures of about forty thousand stars. The results fill ten of the quarto volumes of the *Annals* of the observatory, and furnish a standard scale of magnitude from the first to the twelfth magnitude for stars from the north to the south pole.

An excellent example of organization is furnished by the work of the International Astronomical Society. The great astronomer Argelander proposed to determine the exact places of a hundred thousand northern stars. Seventeen observatories took part, including two in America, Harvard and Albany. In extending the work to the southern stars, Harvard again took a zone. Each zone occupied an observer and a corps of assistants for nearly a quarter of a century. The results of both fill half a dozen volumes of the *Annals* and the cost in salaries alone was about two hundred thousand dollars.

May we see some of the great problems in astronomy solved at the Allegheny Observatory better than ever before, and the work repeated on star after star until the entire field has been successfully covered.

EDWARD CHARLES PICKERING
HARVARD COLLEGE OBSERVATORY

THE RESPONSIBILITIES OF AN OBSERVATORY STAFF[1]

IT falls to me in these dedicatory exercises to say a few words on behalf of the observatory staff, into whose keeping these fine instruments are for the time being placed. You may be sure that we have given much thought to deciding how we might best fulfill this trust, and it is natural that the same question should be a prominent one in the minds of all those who are interested in the welfare of this institution. We are doubtless all agreed that our observatory has not been erected for the purpose of enhancing the reputation of any individual or individuals, nor to enhance the reputation of the observatory itself, nor of the university of which the observatory is the astronomical department. These things are much to be desired in themselves, and we hope that they may come to pass; but if they do come to pass it must be only incidentally, and nothing of this kind must be allowed to obscure the goal toward which we are striving; namely, to add as much as we can to the progress of our science; or, to use the words that were often in the mouth of the

[1] An address delivered at the dedication of the new Allegheny Observatory, August 28, 1912.

first chairman of our observatory committee, "to push forward the frontier of human knowledge."

In the minds of many whose interest in astronomy is general rather than special, we often find the belief that it is the principal business of the astronomer to make discoveries. It is true that there is hardly anything more striking that the astronomer can do than to bring to the attention of the world a new comet, a temporary star, or the like. But valuable as such discoveries are, they do not constitute the kind of work that will most rapidly push forward the frontier of human knowledge. I would, if I might, place an inscription above the door of this observatory and would call to it the attention of each new member of our staff, "Abandon hope of making discoveries, all ye who enter here." This view may seem a radical one to part of my audience, but I am sure that it will meet with ready sympathy among those astronomers here present who have had occasion to give thought to this subject. Some years ago, Professor Cattell, the editor of SCIENCE, asked ten of our leading astronomers to set down in the order of their preference the names of those living Americans who had contributed most to the progress of astronomy. One result of this ballot was very remarkable; it was found that the voters had without exception put the same name at the head of their lists—that of Simon Newcomb. This high place in the esteem of his colleagues was reached by setting on foot and directing the exceedingly laborious computations that would enable us to predict the situations of the sun, moon, planets and some of the fixed stars, with greater accuracy than had hitherto been the case; or, in other words, by following out with greater thoroughness, the consequences of the law of gravitation within the solar system. To this, the principal work of his life, Newcomb continued to add other important investigations up to the day of his death; but throughout his long and fruitful career we find no record of a discovery. Be it well understood that I am using this word with its narrower meaning, and not in the sense that would permit us to speak of Kirchhoff as having discovered the principle of spectrum analysis, or of Langley as having discovered a method of mapping the entire spectrum of the sun.

Let me give one other illustration of what work it is that astronomers themselves deem to be the best. Near the little village of Nyack there lives in modest retirement upon the farm of his fathers and of his own boyhood, George William Hill. Although he is perhaps the greatest genius that this country has as yet borne, it is safe to say that not one person in a thousand, even among people of education, is familiar with his name, much less with his work. But among astronomers, both abroad and at home (possibly more abroad than at home), he is recognized as being one of a very few to whom astronomy of the present day owes most. Here again discoveries form no part of this notable career; and in fact so far as records go, Hill may never have used a telescope. His greatest work is in connection with periodic orbits, the best method yet devised for handling the problem of three bodies under certain restrictions.

You are not getting the impression, I trust, that I wish to belittle the work of discovery. I am merely trying to get the bearing of such work so far as it affects the responsibilties of an observatory staff, at whose disposal have been placed instruments of the first rank. You must first catch your comet before you can make comet investigations, and so with asteroids, double stars and spectroscopic binaries.

Statistical investigations concerning all four of these classes of bodies have recently been made; they constitute additions of the most desirable kind to our stock of knowledge, and have done much to indicate in what directions further additions are to be sought. Apart from all this, if the discovery of a comet (for example) were not otherwise useful, it would frequently justify itself by calling attention to men of promise. It was in this way that the astronomical world has come to have the benefit of the extraordinary talents of Edward Emerson Barnard. With a little telescope purchased out of the meager earnings of his youth, he discovered in rapid succession a surprising number of faint comets. The attention thus attracted to him soon resulted in an appointment at the Lick Observatory, and later one at the Yerkes Observatory, so that he has had access to some of the most powerful instruments in the world. He has used these instruments to excellent purpose and with a diligence that has rarely been equalled; but it is significant that in the past twenty years he has made no further discoveries. In a case like this it would be more to the point to speak of the comet as having discovered the man, than of the man as having discovered the comet.

We are often told that an astronomer pointing his telescope more or less at random to the sky and faithfully recording what he sees or photographs, is bound to add something to our fund of knowledge. While this is true, promiscuous observing is to be encouraged only if nothing else is possible, and is surely never to be encouraged within an observatory. The fact is that astronomy of to-day demands answers to definite questions; the astronomer who goes to his telescope without having one of these questions in mind is at least partially wasting his time. In other words an observatory staff should regard their profession as a branch of engineering, in which the problems to be solved are quite as definite as those, for example, that confront the civil engineer. If this seems to you to be a somewhat dry view to take of so beautiful a subject as astronomy, I would remind you that none save engineers are especially interested in the plans and specifications for a bridge, but that all of us can take delight in the finished structure, either for its utility or its beauty. In the same way the methods employed by the astronomer are almost always of very special interest, while the results of his work appeal to us all as educated men and women. How long will the sun continue to be sensibly as bright and as hot as it is now? How does our sun compare in size and glory with other stars? How comes it that some stars are double, while others (our sun among them) are single? How are the stars distributed in space? What causes some stars to vary in brightness? These are some of the questions to which astronomers are seeking the answers, and the results of these inquiries will surely interest you as deeply as they do the astronomer himself.

Let me now state briefly what specific use we intend to make of our various instruments. Under the north dome is the Keeler memorial reflector, having an aperture of thirty inches. This telescope and the Mellon spectroscope attached to it have been in constant use during the past six years in the prosecution of a single research, the determination of the orbits of spectroscopic binaries. This work we shall continue as long as it remains profitable to do so. Under the same dome is a vertical or tower telescope of nine inches aperture and twenty-nine feet focal length. This is "fed" by a cœlostat mirror on the mount-

ing for the Keeler reflector, and attached to the telescope is a powerful solar spectrograph, the gift of Mr. H. K. Porter. With these we are taking part in the spectroscopic determination of the solar rotation, a project that was set on foot at the last meeting of the International Solar Union, and in which six observatories, in this country and abroad, are cooperating.

Under the southeast dome is the thirteen-inch visual refractor that formed the nucleus around which the old observatory was built. Once the third largest telescope in the world, it has now become the third largest in our observatory. This telescope we now use chiefly for the instruction of the public; with the lecture hall below it (used on cloudy evenings) it forms a public observatory, the privileges of which are freely offered to the people of Pittsburgh. So eagerly has this offer been accepted, that two years ago we found it expedient and possible to extend this work, and to pledge ourselves to continue it in perpetuity.

Attached to the thirteen-inch refractor is a four-inch camera, used to determine the brightness of stars by the extra-focal method. The observing program is made up chiefly of stars that we are observing at the same time with the spectrograph.

In one of the basement rooms on the north side of the building a ten-inch photographic telescope is mounted in a fixed position on an inclined pier and directed toward the north pole of the heavens. The work with this instrument is of an experimental character. If its outcome should be favorable we hope to undertake, probably in cooperation with the Harvard College Observatory, the compilation of a catalogue of faint stars by entirely new methods.

At the west end of our building is a four-inch transit instrument with which we are still maintaining the extensive time-service installed by Langley in 1869. As auxiliaries to this instrument we have three second-pendulum clocks. One of these is a Riefler clock maintained under constant pressure and temperature, and this proves to be a time-piece of unusually accurate performance.

Lastly we come to the Thaw memorial telescope, under whose dome we are assembled this afternoon. Last summer when we fixed the date for this dedication, we thought that this telescope would be quite complete by to-day; but it appears that at least another year must elapse before the objective can be ready. This is due to the difficulty of securing a suitable disk of flint glass, the crown disk having been delivered some months ago. The aperture of the telescope is to be not less than thirty inches, and unlike most other refractors of the largest size, it is to be primarily a photographic instrument. A twelve-inch correcting lens is to be provided; it will be a matter of only a few seconds to put it into the optical axis, thus changing the color curve into one that will be suitable for visual observations. The mounting has all those appurtenances (and no other) that modern practise has shown to be desirable. Throughout its design and construction, efficiency for astrometric work was the chief object in view.

With the Thaw telescope we contemplate an attack upon three problems; first, the accurate determination of the distances of many stars. How extensively we shall go into this work will depend upon the activities of certain other observatories that have declared similar intentions. But the need of such determinations is one of the most pressing in astronomy and it is likely that the telescope before us can be profitably occupied in this work for many years to come. Secondly, we owe it to our suc-

cessors of perhaps a hundred years hence to determine with great accuracy the relative places of stars that form globular clusters. It is only in this way that we shall ever be able to say what the motions within these clusters are; and this in turn will go far toward telling us what these objects themselves are, and what place they occupy in the universe of stars. A third research that we contemplate is the determination of the brightness of faint stars by means of extra-focal images, or otherwise expanded star disks. This method for determining stellar magnitudes is surpassed in accuracy only by the selenium photometer, which is however not applicable to faint stars.

These are the things that we have in mind, but we reserve the right to alter these intentions as soon and as often as circumstances may demand. I should not wish to commit myself, much less any other man, to an unalterable routine of work. But I do wish that it were in my power to commit the present staff and its successors to the policy of doing that thing which is most in need of attention, within the limits set by our resources and equipment, both personal and instrumental. If we do not succeed in contributing our fair share to the progress of our science, I think it will not be because we have not tried; and I believe I can make this promise for those who are to come after us, as well as for ourselves. For it would be a strange thing if the devotion that has been lavished upon the Allegheny Observatory by William Thaw and his sons, by Langley, Keeler, Wadsworth and Brashear—it would be a strange thing, I say, if the example of such devotion should ever cease to be a compelling incentive to any who may have the privilege of working within these walls, and if the tree that these men have planted and nourished should cease to bear fruit for many a season to come.

FRANK SCHLESINGER
ALLEGHENY OBSERVATORY

M. HENRI POINCARÉ

THE city of Paris is commonly regarded as the greatest mathematical center of the world, and Henri Poincaré stood for a number of years at the head of the Paris mathematicians. He was a mathematician in the broadest as well as in the deepest sense of this term. He started as an engineer in 1879, but soon thereafter he entered upon his life work as university instructor, first at Caen in December, 1879, and afterwards at Paris from October, 1881, until his death on July 17, 1912. His positions in the University of Paris were as follows: Maître de conferences d'analyse, chargé du cours de mécanique physique et expérimentale; professeur de physique mathématique et de calcul des probabilités, and professeur d'astronomie mathématique et de mécanique céleste.

He was born at Nancy, April 29, 1854, and was educated successively at the Lycée de Nancy, l'École Polytechnique and at l'Ecole nationale supérieure des mines, receiving his doctor's degree from the University of Paris in 1879. He was a very bright student and received first rank at the entrance examination of l'Ecole Polytechnique. At the early age of 32 he was elected as a member of l'Académie des Sciences, and for this occasion he prepared, in 1884, a statement entitled "Notice sur les travaux scientifiques de M. Henri Poincaré."

Although this "Notice" was written less than five years after Poincaré had begun the publication of his researches, it reviews a large number of his published articles along the following three lines: (1) Differential equations, (2) General theory of functions, (3) Arithmetic or the theory of numbers. He emphasizes the fact that he did not pursue his researches in these three directions independently of each other, but that the results obtained along these various lines threw light on each other, and that his work along each

one of them was greatly aided by the work along the other lines.

The breadth of scholarship exhibited by Poincaré in his early writings and his great ability to observe relations between apparently widely different subjects became still more pronounced as he grew older, but we observe even at this early date a mind of very broad sympathies and of extraordinary ability to generalize. His principal writings may be classed under the following four headings: pure mathematics, analytic and celestial mechanics, mathematical physics, and the philosophy of science.

In 1909 Emile Borel published, in the journal called *La Revue du Mois,* an article on the method of Poincaré. Parts of this were translated for the first article in the *Bulletin of the Calcutta Mathematical Society.* In view of the great importance of the method of work, we quote parts of this translation.

> The method of Poincaré is essentially active and constructive. He approaches a question, acquaints himself with its present condition without being much concerned about its history, finds out immediately the new analytical formulas by which the question can be advanced, deduces hastily the essential results, and then passes to another question. After having finished the writing of a memoir, he is sure to pause for a while, and to think out how the exposition could be improved; but he would not, for a single instance, indulge in the idea of devoting several days to didactic work. Those days could be better utilized in exploring new regions.
>
> All this is not specially applicable to mathematics. Let us examine more closely the mechanism made use of for discovery. The essential feature of that mechanism is, as we have already pointed out, the construction of new formulas. It is not useless that some stress is laid on this point, for this constructive power is the essential trait of the genius of Poincaré. The non-mathematical readers can be made to understand all this by means of a comparison. They know what arithmetical calculation is, and are often led to believe that mathematicians are in the habit of making interminable additions, multiplications, etc., and also extractions of cube roots.
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> In reality, arithmetical operations are unique combinations of integral numbers formed of units which are all equal to one another. These operations can be compared to the construction of regular walls by means of bricks of uniform sizes. The work requires only some patience and a little care. On the contrary, analytical operations make use of extremely numerous materials and their variety is comparable to those of structures, where stone, marble, wood, iron, etc., are used. These operations are as different from each other as cuirassé is from a Gothic church. They have also with the architectural constructions this in common, that an impression of beauty is produced by the simplicity and elegance of the essential lines, without exhibiting any of the effort by means of which the result has been obtained.

Poincaré was a great pioneer, boldly entering into unexplored regions and noting some of the most important objective points and then leaving to others the details of organization. In the words of Borel he was more of a conqueror than a colonizer, and he attached little importance to conceptions which can not be realized in a concrete form. In this respect he may be compared with men of action; his method of work was too active to leave much room for such reflections as do not lead to concrete results.

On January 28, 1909, Poincaré was received as member of l'Académie Française, and on this occasion M. Masson, Directeur de l'Académie, delivered an address in which he entered into many details in Poincaré's career. A translation of a part of this address appeared in the *Popular Science Monthly,* September, 1909, page 267. A sketch of Poincaré's career may also be found in the *Independent,* October 5, 1911, under the general title of "Twelve Major Prophets of To-day." An elementary article by Poincaré on the foundations of geometry appeared in the *Monist,* October, 1898, and a number of his other articles have been translated into English from foreign journals.

In 1909 Ernest Lebon published, in his series entitled "Savants du Jour," a little volume on Henri Poincaré. This volume contains a list of his 436 different publications. The largest number of articles classed under one heading is 98, under the general

heading of Pure Analysis. The number of his other articles in pure mathematics at this time was 46, 23 being classed under each of the two headings, analysis applied to arithmetic and analysis applied to geometry. From this it appears that only about one third of Poincaré's writings were devoted to pure mathematics.

Poincaré won great fame in connection with his prize memoir relating to the problem of three bodies. In 1885 King Oscar II. of Sweden offered a prize for the solution of a question in reference to this general problem, and one half of this prize was awarded to Poincaré for his article entitled, "Sur le problème des trois corps et les équations de la dynamique," published in the *Acta Mathematica* in 1890. In the *Bibliotheca Mathematica* for 1904, page 198, Eneström calls attention to the interesting fact that the copy of this memoir for which the prize had been actually awarded contained a serious error, and that the given published article was really prepared for the press after the prize had been awarded.

Among the other prizes received by Poincaré we mention the gold medal of the Royal Astronomical Society of London, the Sylvester medal of the Royal Society of London, the Bolyai prize of the Hungarian Academy of Sciences, and the Lobatchefsky gold medal of the Kasan Mathematical Physics Society. In addition to these foreign prizes Poincaré received two prizes from the Paris Academy and a gold medal from the French Association for the Advancement of Science. He received an honorary doctor's degree from each of the following universities: Cambridge, Christiania, Oxford, Glasgow, Brussels and Stockholm.

To those who would like to establish a connection between the university athlete and intellectual greatness, between physical powers and the intellectual giant, Poincaré was a decided disappointment. He was only about 5 feet 5 inches in height, was somewhat stooped, at least in the latter part of his life, and his weight was about 154 pounds. Even as a child he was rather weak and did not generally engage in the rougher sports of the boys of his age. He cared little for politics and achieved his greatness solely through his scholarly services. When he entered the French Academy he was told that he was born a mathematician and would die a mathematician. He had, however, the good fortune to live in a country where mathematical attainments are held in high esteem even by the general public.

As evidence of the high popular regard for Poincaré we may mention the fact that the French Ambassador occupied the chair last May when Poincaré gave the first lecture of a series of four at the University of London. The account of Poincaré's funeral which appeared in SCIENCE, August 9, 1912, furnishes further evidence along this line. On this occasion M. Jules Clarétie spoke as follows, according to *Nature* of July 25:

> In the name of the French Academy, I have the honor of saluting Henri Poincaré on behalf of a company of which he was justly one of the most illustrious members. When his colleagues called him, not yet thirty-two years of age, to take his place amongst us, it was a poet that this mathematician, this geometer, this philosopher, this poet of the universe, succeeded. And, from the first day, we were conquered by the simple and limpid eloquence of this master writer, who, knowing everything, verifying everything, illuminated with his definitions, animated with his observations and guided with his counsels our researches, the study of our language.
>
> It is not to-day, nor is it here, that one must study the work of this great man, who, scarcely full-grown, had already at one bound mounted to the summits. One might say, in many and eloquent tones, how much the country owes to this son of the borders of Lorraine, to this child of Nancy, who has shed luster upon the whole of France. Before his grave the French Academy can only express its sorrow, and deplore the loss of a great seeker after truth, that stopped all too soon in the midst of his work. He would be a bold man who would assess the worth of a scholar. In celebrating his fame, we can only do homage to a philosopher whose thoughts will have so fertile, so profound an action on the new generations.
>
> Passion for scientific truth did not suffice for him, he loved literary beauty, and this incom-

parable mathematician was a strong supporter of good writing, of those humanities which for so long have guided the French genius along a right and safe road. One might hear him, when the dictionary was under discussion, ask about the origin, and, as it were, the titles of nobility of words. This modern, who stimulated contemporary life by his discoveries and his calculations, defended with boldness the heritage of our ancestors. He knew that the French language is itself a country, and, against every perilous invasion, this soldier of sound speech stood firmly at the frontier.

While it would be futile to try to give an account of the mathematical work of Poincaré in such a hasty sketch, yet it seems hardly appropriate to omit entirely the things which were dearest to him. One of the earliest problems which he attacked was the study of linear differential equations with rational or algebraic coefficients. This study led him to the discovery of new functions which may be regarded as generalizations of elliptic and of modular functions. These functions were characterized by the property that they are invariant under certain linear transformations. He was thus led to the study of various groups of transformations, and in his "Notice," to which we referred above, he remarks that there is a theory which has been equally useful to him in all his researches, namely, that of the groups formed by linear substitutions. In fact, these substitutions play a preponderant rôle in the study of linear equations and in that of arithmetic forms. It is to this circumstance that one ought to attribute the interrelations, often unexpected, between the theory of numbers and the theory of Fuchsian functions, theories which, moreover, do not at first appear to have any point of contact.

He pointed out relations between the theory of complex numbers and the theory of continuous groups, and thus he threw new light on these far-reaching subjects. The theory of the solution of systems of an infinite number of linear equations with an infinite number of unknowns is largely due to Poincaré. He was the first to establish definite criteria of convergence in reference to the infinite determinants employed by the American astronomer, G. W. Hill, with so much success. It should, however, be observed that infinite determinants had been studied earlier by E. Fürstenau and T. Kötteritzsch, and that these determinants should not be accredited to G. W. Hill, as is sometimes done.

Poincaré wrote a number of books especially on mathematical physics, but the three books which are perhaps the most commonly known deal with philosophical questions and bear the following titles, respectively: "La Science et l'Hypothèse," "La Valeur de la Science," and "Science et Method." In regard to the first of these, the Director of the French Academy said at the time when Poincaré entered this academy: "By the sale of 16,000 copies of 'La Science et l'Hypothèse' you have increased your personality (personnel) ten-fold."

He was fond of traveling and many Americans recall his visit to the St. Louis Exposition, in 1904, where he delivered an address entitled, "The Present and the Future of Mathematical Physics." This address was translated for the *Bulletin of the American Mathematical Society* by J. W. Young, and published in the February, 1906, number of this journal. Poincaré visited all the countries of Europe and also some of the countries of Africa. He was married and had four children—three daughters and a son.

The great mainspring of Poincaré's activity was seeking the truth. This made his life both simple and beautiful. Seeking the truth implies an open acknowledgment of ignorance. In fact, one of the strongest mathematical methods consists of putting an x for the unknown; but how could we put an x for the unknown unless we were willing to admit that we are ignorant in regard to this fact. Every one who has worked in elementary algebra knows that much is frequently gained by admitting our ignorance and by calling some particular ignorance x and another particular ignorance y, etc. Even in his mature years Poincaré could honestly ask the question "La terre tourne-t-elle?" Things that are commonly accepted as true but have not been fully established, frequently offer the most

important fields of research, and the great investigator does not always accept the views of the masses as evidence of truth.

At the funeral of Poincaré the French Minister of Public Instruction remarked that all his work, all his life, was animated by a prepossession, which he expressed in this thought: "The search for truth must be the goal of our activity; it is the only end that would be worthy of it."

An open confession of some of the hidden ignorance of the mathematical scholars has furnished the starting point of many of the most important advances in recent years. In this way Weierstrass started some of the fundamental work relating to continuous functions, and in this way Poincaré clarified a number of questions relating to foundations, especially to the foundation of geometry. The mathematical refinements resulting from such new viewpoints have already taken root in the minds of leaders in other sciences. For instance, Boltzmann said: "The fact that the actual behavior of gases is represented by a curve which can not be differentiated and hence can not be represented graphically leads to great difficulties."[1]

In closing this brief appreciation we may perhaps fittingly quote the words of Sir G. H. Darwin, President of the Fifth International Congress, which met recently at Cambridge, England. At the opening meeting of this congress, held August 22, 1912, Sir Darwin said: "Up to a few weeks ago there was one man who alone of all mathematicians might have occupied the place which I hold, without misgivings as to his fitness. I mean Henri Poincaré."

G. A. MILLER

UNIVERSITY OF ILLINOIS

[1] Klein und Hoefler, "Grenzfragen der Mathematik," 1906, p. 8.

SCIENTIFIC NOTES AND NEWS

THE New York State Education building will be dedicated with elaborate exercises on October 15, 16 and 17. The dedicatory address will be made by Dr. Andrew S. Draper, Bureau of Education, and in the course of the exercises a number of addresses will be made, including one on museums by Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, and one on Educational Extension by Dr. C. R. Van Hise, president of the University of Wisconsin.

PROFESSOR STIMPSON J. BROWN, head of the department of mathematics and mechanics at the Naval Academy at Annapolis, and Professor H. M. Paul, the second ranking officer of the department, have been relieved from duty at the academy and Professor Harry E. Smith has been named as head of the department.

PROFESSOR THEODORE FUCHS, director of the geological department of the Royal Natural History Museum at Vienna, has celebrated his seventieth birthday.

R. O. E. DAVIS, Ph.D., lately physicist in the Bureau of Soils, U. S. Department of Agriculture, has been appointed head of the Division of Soils Water Investigation, in the same bureau, to fill the vacancy in that office occasioned by the death of Dr. W J McGee.

DR. F. D. HEALD, professor of botany in the University of Texas, has resigned to become pathologist to the Pennsylvania Chestnut Tree Blight Commission, Philadelphia, Pa.

DR. S. R. KLEIN, formerly professor of histology and embryology at the Fordham University School of Medicine, New York, has been placed in charge of the new research laboratories of the Hahnemann Medical College, Chicago.

MR. OWEN M. JONES, who has been carrying on investigations during the last year for the Michigan-Lake Superior Power Co. at Sault Ste. Marie, Michigan, has resigned his position at the Tulane University of Louisiana, where he was in charge of the department of civil engineering, to accept a permanent position with the Power Co.

PROFESSOR HUGO DE VRIES, on his present trip to Alabama to visit the original locality for *Œnothera grandiflora* (see SCIENCE for

August 30), stopped first for a day at Tuscaloosa, where he was the guest of Dr. Eugene A. Smith, state geologist, one of the pioneer students of the relations between the geology and vegetation in the southeastern states. On the evening of September 21 he was given an informal reception by the faculty of the University of Alabama, in Smith Hall, and described briefly some of his recent observations on mutation in *Œnothera*. While in Alabama he was accompanied by Mr. H. H. Bartlett, of the U. S. Department of Agriculture, who is also a student of *Œnothera* mutants. After visiting Mississippi, Louisiana and Texas, he will go late in October to Florida to study the phytogeography of that unique peninsula under the guidance of Dr. John K. Small, Professor P. H. Rolfs, and perhaps other botanists.

Professor R. B. Dixon, of the department of anthropology, of Harvard University, will spend his sabbatical year in the Orient. During the autumn he will be in western Thibet, but during the winter he expects to pursue his ethnological researches in the Malay states.

Professor A. S. Hitchcock, systematic agrostologist of the United States Department of Agriculture, has gone to the West Indies for the purpose of studying and collecting grasses. He is accompanied by his son, Mr. Albert E. Hitchcock, as assistant. They will go first to Jamaica and later to various points in the Windward Islands, probably visiting last the island of Trinidad.

Dr. A. Hrdlička, of the U. S. National Museum, has returned from an expedition to Liberia and Mongolia.

Professor C. W. Moulton, of Vassar College, has been granted a leave of absence from the college for the year 1912–13. He will pursue special investigations at the University of Berlin.

Leave of absence for the coming year has been granted by Oberlin College to Professor F. E. Leonard, professor of physiology and director of the men's gymnasium. Dr. Leonard will divide his time between work under Professor Kelly at the Johns Hopkins University and study and travel in Europe.

Mr. J. B. Speer, registrar in the University of Montana, has resigned and has gone to Stanford University as private secretary to President Jordan.

Professor E. C. Schmidt, in charge of the department of railway engineering of the University of Illinois, has been commissioned by the Japanese government to design a railway dynamometer car for the imperial government railways. The car will be constructed in this country under the supervision of Professor Schmidt, and is expected to be delivered next spring to the representative of the Japanese government.

Professor G. H. T. Nuttall, of Cambridge University, will give a Harvey Lecture in New York City on October 12 on "The Relapsing Fevers."

"Social Hygiene" was the subject of a recent lecture at the University of California by Dr. Richard C. Cabot, of the Harvard Medical School. He urged the establishment of an efficient national public health department at Washington, physical examination and adequate medical care by school physicians and nurses for every child in the public schools, more attention to industrial hygiene and occupational diseases, and development by which the public hospitals shall more and more care for the general public health.

The Earl Lectures, supported by an endowment of $50,000 given to the Pacific Theological Seminary by Mr. Edwin T. Earl, of Los Angeles, are being given in Berkeley by Dr. Arthur C. McGiffert, professor of church history in Union Theological Seminary, of New York. His subject is "The Rise of Modern Religious Ideas." As a state university, the University of California has no theological department. Several denominations, however, the congregationalists, baptists, christians and unitarians, have established independent theological seminaries in Berkeley which devote their strength and resources wholly to doctrinal and strictly theological training, while their students attend

the university for instruction in Greek, Latin, Hebrew, modern languages, history, philosophy, economics, sociological subjects, etc.

PROFESSOR G. FREDERICK WRIGHT, president of the Ohio State Archeological and Historical Society, delivered the main address at the laying of the cornerstone of the museum in Columbus, for the erection of which $100,000 was appropriated by the Ohio legislature. The building, which stands at the entrance of the state university campus, will be two hundred feet long, fifty feet wide and three stories high, and is planned to allow large additions in the future. The chosen purpose of the museum is the housing of the society's unusual collection of relics of the Mound Builders, which is recognized as the finest gathering of such material in existence. Professor Wright has also secured an appropriation of $50,000 from the legislature for the erection in Fremont, Ohio, of a memorial to President Hayes, which will contain the Hayes Library of Americana, which is the famous Clark Library of Cincinnati with the additions made by Mr. Hayes.

A PUBLIC meeting will be held at the Mansion House, London, on October 23, in support of the memorial to Lord Lister.

DR. LEONARD W. WILLIAMS, instructor in comparative anatomy at the Harvard Medical School, was crushed to death by an elevator in one of the school buildings on September 26. Dr. Williams was born at Muskogee, Okla., in 1875, and received his bachelor's degree from Hanover College, his master's degree from Princeton University and his doctor's degree from Brown University, where he was assistant professor of biology; he was the author of important researches on embryology and comparative anatomy.

THE deaths are announced of Dr. Stanley Dunkerley, formerly professor of engineering in the University of Manchester and a member of the Royal Institution of Civil Engineers; of Dr. Ernst Becker, emeritus professor of astronomy at Strasburg, and of Dr. Aurel Török, professor of anthropology at Budapesth.

CIVIL service examinations are announced for two positions in the department of the interior, one for specialist in rural education at an annual salary of $3,000, and one as collector and compiler of statistics at a salary of $2,400.

THE Transcontinental Excursion of International Geographers (Professor W. M. Davis, of Harvard University, director), celebrating the sixtieth anniversary of the American Geographical Society, of New York, will be the guests of the University of Virginia on October 12. A symposium will be held at the university in the afternoon on the status of geographical teaching in European universities, in order to show the serious attention that is there given to the fundamental subject of geography as a study of mature grade, presented by expert professors. Addresses will be made by the following speakers: Dr. Joseph Partsch, professor of geography, University of Leipzig, late president of the Geographical Society of Leipzig; Dr. Eugen Oberhummer, professor of geography at the University of Vienna, president of the Geographical Society of Vienna; Lucien Gallois, professor of geography, University of Paris, associate editor of the *Annales de Geographie;* George G. Chisholm, lecturer on geography, University of Edinburgh, secretary to the Royal Scottish Geographical Society; Emile Chaix, professor of geography, University of Geneva and School of Commerce. Addresses by American geographers will be made by Professors W. M. Davis, of Harvard University, A. P. Brigham, of Colgate University, and Mark Jefferson, of the State Normal College, Ypsilanti, Michigan.

THE Riberi prize of the University of Turin, amounting to $4,000, will be awarded after the close of the year 1916 for the work which is adjudged to have most advanced the science of medicine.

IT is announced that the following sums have been bequeathed by Madame Jonglart for the furtherance of science in France: 50,000 francs to the Collège de France; 95,-

000 francs to the faculty of science of the Sorbonne, of which amount 55,000 francs is to be devoted to the zoological laboratory; 95,000 francs to the museum; 50,000 francs to the faculty of medicine; 70,000 francs to the School of Advanced Studies; 150,000 francs to be divided between the Geographical and Anthropological Societies and the Association for the Advancement of Science, and 139,000 francs to various scientific and charitable institutions.

The Natural History Museum at South Kensington has, as we learn from the London *Times*, received the most valuable gift of the kind which has ever been bestowed upon it. It is the gift of a very extensive collection of exotic and palearctic butterflies and moths which belonged to Mr. H. J. Adams, of Enfield, who died in March last. It is understood that Mr. Adams spent more than £40,000 in acquiring this collection. By his will he had left his collection of butterflies and moths upon trust, with the consent of the residuary legatees, to offer them to the South Kensington Museum for the use of the nation, and his British collection of lepidoptera to the Enfield Entomological Society. The collection of butterflies and moths, which has recently been removed to South Kensington, comprises about 150,000 specimens, contained in 68 cabinets. All the specimens are in excellent condition, and are labelled with the details of the respective localities in which they were obtained. There are at least 200 type specimens of new species described by Mr. Adams.

A press cutting quoted in *Nature* states that Mr. Fisher, prime minister, Australia, referred to the forthcoming visit of the British Association in 1914 in his budget speech on August 1 as follows: "We have been advised that about half as many more members of that association are likely to visit the commonwealth than was anticipated when our invitation was accepted. This will entail an increase in the amount of money which I propose to give towards their expenses; and, speaking for this parliament and country, I say that no greater compliment could be paid to Australia than the fact that our visitors are to be increased in number. It is usual a year or eighteen months before the visit is made to send a representative man of the same class as themselves to get into communication with them. We propose to incur that expenditure pending the expenditure of a larger amount to cover their expenses."

Preventive medicine, hygiene and public health will be the subject of a series of lectures, open to the general public, to be given at 2 o'clock every Friday at the University of California Hospital, the medical department of the university, on Parnassus Avenue, San Francisco. Federal, state and municipal control of disease, vital statistics, pure food, pure milk and pure water, sewage disposal, sanitary engineering, disinfection, social economics and social service in relation to public health will be some of the subjects dealt with.

The council of the Institute of Chemistry, London, are making an endeavor, as we learn from the London *Times*, to raise a fund for new buildings for the institute. Owing to alterations which the London County Council propose to carry out by the widening of Southampton-row, at the rear of the present premises of the institute, 30 Bloomsbury-square—it will not be possible to effect a renewal of the present lease. The council of the institute wish, therefore, to take this opportunity to secure more suitable and permanent headquarters. It is reckoned that with economy adequate provision for the work of the institute can be obtained for about £15,000. The appeal has now been issued nearly three years, and the amount promised to date is about £10,000. As the council will proceed to select a site and prepare plans at the close of this year, they are very desirous of being assured that the full sum of £15,000 will be at their disposal, and it is hoped, therefore, to raise the £5,000 which is still required before the end of October.

The U. S. National Museum of the Smithsonian Institution has recently issued a paper as a contribution to our knowledge of bees

and Ichneumon flies, by H. L. Vierick, of the Bureau of Entomology, U. S. Department of Agriculture. In this paper Mr. Vierick describes twenty-one new genera and fifty-seven new species of Ichneumon flies, one new genus of which is named after Dr. Marcus Benjamin, editor of the publications of the U. S. National Museum.

UNIVERSITY AND EDUCATIONAL NEWS

MR. T. JEFFERSON COOLIDGE has given $50,000 for the construction of one of the buildings for the Chemical Laboratory of Harvard University.

IT is announced that the Graduate School buildings of Princeton University, now in the course of erection, will in all probability be formally opened in June, 1913, instead of the following September, as originally planned.

THE original purpose of American colleges was mainly to train men for the ministry, but at present Harvard gives to this profession barely 2 per cent. of its graduates; Yale now contributes 3 per cent. This and other changes in the professions favored by college graduates are described in a bulletin by Bailey B. Burritt on "Professional Distribution of University and College Graduates," just issued by the United States Bureau of Education. The decline in the numbers going into the ministry has been accompanied by a rise in the professions of teaching, law and business. All three have been more or less consistent gainers at the expense of the ministry. At Harvard the ministry yielded the leadership to law after the revolutionary war, and law remained the dominant profession of Harvard graduates until 1880, when business took the lead. At Yale the ministry competed successfully with law until after the middle of the nineteenth century, when law took the ascendency and kept it until 1895, being then displaced by business. At the University of Pennsylvania one fourth of the graduates used to go into the ministry; now about one fiftieth do so. Oberlin College, founded with strong denominational tendencies, shows the same story of the decline in numbers of men going into the ministry. At the University of Michigan, out of over 15,000 graduates, only 188 have become ministers. Aside from their contributions to the clergy, most of the universities and colleges have had favorite professions. At Columbia, Dartmouth and Michigan, for instance, it is law; at Pennsylvania it is medicine; at Oberlin, Wisconsin, and many others, particularly the co-educational institutions, it is teaching. A final summary of 37 representative colleges shows that teaching is now the dominant profession of college graduates, with 25 per cent.; business takes 20 per cent.; law, which took one third of all the graduates at the beginning of the nineteenth century, now claims but 15 per cent.; medicine takes between 6 and 7 per cent. and seems to be slightly on the decline; engineering is slowly going up, but still takes only 3 or 4 per cent.; while the ministry takes 5 or 6 per cent.

WITH the appointment of Frank B. Moody, assistant state forester of the Wisconsin forest service, the University of Wisconsin has taken the first steps toward the formation of a course in forestry. Mr. Moody is a graduate of Bates College, Maine, and of the forestry school of the University of Michigan. Mr. Moody's main work will be to organize a school for forest rangers and to give the courses on woodlot management in the university. The forest rangers' course will consist of two sessions of six months each extending over a period of two years. One half of each session will be spent at the university during the fall and winter, the other half in the field during the spring and summer, where instruction will be given by direct practical work on the state forest lands. It is expected the new course will be ready for students by January first, 1913.

AMONG promotions in the faculty of Oberlin College is that of Dr. George David Hubbard, to be professor of geology on permanent appointment and head of the department. Among the new appointments the most important is that of Dr. Alan W. C. Menzies as permanent head of the department of chem-

istry, to succeed Professor Frank Fanning Jewett, who retires on the Carnegie Foundation after thirty-two years of service. Dr. Menzies is an alumnus of the University of Edinburgh and has been a graduate student in Leipzig, Aberdeen and in the University of Chicago. Among European appointments Dr. Menzies was assistant professor of chemistry in Heriot-Watt College, Edinburgh, in 1898–1901, and professor of chemistry in St. Mungo College, Glasgow, from 1902 to 1908. He was research fellow in the Davy-Faraday Laboratory, London, in 1901. He is a member of the American Chemical Society, the London Chemical Society and fellow of the Royal Society of Edinburgh. Although retired, Professor Jewett will have a laboratory room in the chemistry building, and plans to give the college service in some much needed work on its mineralogical collections.

Edith M. Twiss, Ph.D. (Chicago), has been appointed head of the department of botany, Washburn College, to succeed Dr. Ira D. Cardiff. James P. Poole, B.G. (University of Maine), has been appointed instructor in the department.

Dr. Harry Beal Torrey, formerly associate professor of zoology in the University of California, has assumed the duties of professor of biology in Reed College, Portland, Oregon.

A. B. McDaniel, of the University of South Dakota, has been appointed assistant professor of civil engineering at the University of Illinois.

DISCUSSION AND CORRESPONDENCE

DRIESCH'S VITALISM AND EXPERIMENTAL INDETERMINISM

In Science of June 16, 1911, I tried to point out the relation of perhaps the most widely known and most influential brand of vitalism —that of Driesch—to experimentation. I set forth that Driesch's vitalism results in "experimental indeterminism," such that "you can not make a statement *which will hold,* that a given arrangement of physical components will act in a certain definite way (even after you have observed how it acts)," because with the same physical configuration different entelechies, or the same entelechy in different manifestations, may be at work, determining diverse results in different cases. Thus I held that it nullifies the fundamental postulate of experimental work, that "when two cases differ in any respect there will always be found a preceding difference to which the present difference is (experimentally) due." I tried to show what a radical difference this would make between biology and other parts of science, in respect to the theory and practise of scientific work, holding it equivalent to an "admission that the principle on which experimental investigation is based breaks down when applied to biology."

In a following number of Science (July 21, 1911) Lovejoy takes sharp issue with my exposition of Driesch's vitalism, saying:

> A closer scrutiny of the doctrine's implications will, I think, disclose in it no such anarchical propensities (p. 78). I think Jennings misconceives Driesch's position in ascribing to him a wholesale "experimental indeterminism" (p. 78).

And after an exposition of Driesch's argument as he conceives it:

> There need in this be nothing arbitrary, nothing to baffle the purposes of the experimenter (p. 78). In all this argument for the non-mechanical nature of organic phenomena there is nothing whatever that necessarily "exempts from experimental determinism . . . that immense field of developmental processes which lies between the egg and the adult," or that necessarily nullifies the experimentalist's postulate that "when two cases differ in any respect there will always be found a preceding difference to which the present difference is (experimentally) due" (p. 80).[1]

And in the classifications of the kinds of vitalism given by Lovejoy in earlier papers (Science, November 26, 1909; and April 21, 1911), he does not so much as mention as one of the possible kinds a vitalism which distinguishes the organic from the inorganic in

[1] What Lovejoy gives here is in reality an exposition of the conclusions which he himself might draw from Driesch's data—assuming these to be the conclusions which Driesch draws.

this profound way. Thus if his point of view is accepted my paper quite lacks a *raison d'être;* I was combating windmills.

In my former paper I made no attempt to show that Driesch's views were of the character that I set forth, because it seemed to me (and still seems to me) that he had stated, in his published works as fully and unequivocally as it is possible in words, that they are of that character; and that, moreover, his whole argument loses its coherence and becomes incomprehensible if they are not.[2] I therefore did not expect any one who had made a careful examination of Driesch's "Science and Philosophy of the Organism" to question this.

Since, however, it has been questioned by one so competent as Lovejoy, with the intimation, as quoted above, that my own scrutiny had not been sufficiently close, it is of interest to learn Driesch's own opinion on this point, when the matter at issue is put explicitly before him. I quote, by permission, from letters received from Dr. Driesch:

> You are quite right in saying "the biologist can not from a knowledge of the total physical configuration predict what will happen even after he has observed it." This is indeed a consequence of my vitalism and I am very glad to see that you fully appreciate it.
>
> I reject absolute indeterminism but *accept* experimental indeterminism.
>
> In other words: A complete knowledge of all physico-chemical things and relations (including possible relations) of a given system at the time t gives *not* a complete characteristic of that system in the case that it is a living system.
>
> Or: Two systems, absolutely identical in every physico-chemical respect, may behave differently under absolutely identical conditions, in case that the systems are living systems.
>
> For: the specificity of a certain entelechy is among the complete characteristics of a living organism, and about this entelechy knowledge of physico-chemical things and relations teaches *nothing.*
>
> My short formula about the matter in question is: No absolute, but "experimental" indeterminism.

Dr. Driesch's statements of the matter are then fully as strong as my own. If he understands his own philosophy, it therefore appears to me that the further reasoning in my former paper was quite justified, and is entitled to the careful consideration of any others who have leaned toward Driesch's vitalism without realizing that it means experimental indeterminism.

H. S. JENNINGS

[2] Driesch's argument is one by exclusion, running essentially as follows: Since there are no diversities in the physical conditions that explain satisfactorily the diverse results in certain different cases, and since we must hold to determinism, it follows that there must be something non-physical (*i. e.,* entelechy) to account for the diversities in results. It appears to me that the failure to correctly apprehend Driesch's argument is what causes Lovejoy to intimate frequently that the entelechy concept is superfluous in Driesch's vitalism; merely "dragged into the situation," as he expresses it. Without entelechy a yawning hiatus is left in Driesch's system; it is all that saves him from absolute indeterminism.

ZOOLOGICAL NOMENCLATURE

TO THE EDITOR OF SCIENCE: IN SCIENCE for August 9, my esteemed friend Dr. Kingsley, makes a plea for various exceptions to the rule of priority in names of animals and to other rules which have been adopted by the Commission on Nomenclature of the International Zoological Congress.

It is no doubt exasperating to many zoologists who have to use only a few systematic names in their work and then at long intervals, to find that in these intervals older names, carelessly or ignorantly neglected in the past, have risen to take their places. It is also exasperating to professional taxonomists and students of geographic and other relations of species, to be told that their efforts to bring past confusion into order shall be set aside whenever these efforts discommode workers in other fields of zoology, who for the most part neither know nor care for the part accurate bookkeeping must play in the study of systematic zoology and botany.

Taxonomy with geographical and geological distribution constitutes a science by itself,

with methods of its own wholly separate from those of anatomy, embryology and histology. We have found, by weary experience, that either the use of names must be governed by rule, or else each man may call anything whatever he pleases. The latter has been done too long. We have been for eighty years making progress toward order, and the Zoological Commission has done fairly well in bringing the variant points of view of actual workers in taxonomy into practical harmony. Compromises have been necessary, but we must remember that no compromise not founded in the nature of things will be respected by future workers. The shield of high authority of men like Cuvier has not sufficed to cover his lapses of failure to recognize the work of earlier but less favored authors. Investigators who deal with a few common species may use as vernacular names words like *Amphioxus, Bdellostoma* and the like, not sanctioned by priority, but there is no line which taxonomists can draw which should retain these names invalidated under the law of priority, while retaining order in the other parts of the taxonomic system.

The chief real confusion centers about the need to restrict to a definite type the wide-ranging, ill-defined, incoherent groups of some of the earlier systematists. The genera of Linnæus correspond in general to the families of to-day, while in very many cases, the same species, under other names, appears in two or more different genera.

To limit these genera we have in general two methods. One is to settle the matter on the basis of the words of the original author. If he designates no type, let the first species he names under a genus stand as type. This method has the tremendous advantage of absolute fixity. It would involve a few dozen changes from current nomenclature, but it would stand once for all. Some writers still adhere to it, through thick and thin.

The other method allows the author who deals next with the genus to fix its type. The first one who does so completes the genus and fastens it once for all on some definite species. This method makes necessary much bibliographic research, otherwise unprofitable, and as many writers have no clear conception of generic type, it is often not certain whether such have fixed the type or not.

A third method, that of elimination, by which the type is fixed of a genus for the species which remains after the others have been removed has never been defined and is not practicable. The second method, as a compromise between the first and third, was adopted at the Boston meeting of the Zoological Congress in 1909. If it fails, taxonomists will have no recourse but to fall back into two mutually criticizing camps: those who fix a genus absolutely to the first species named, and those who fix it where they please, according to their treatment of the exigencies of elimination.

The present writer believes that the first species rule would have been best, but as it can not secure a majority vote of taxonomists, he favors the second rule adopted unanimously at Boston. Non-taxonomists have no rights in this matter. We might as well ask them to make their cells visible to the naked eye, laying aside their technique, as for them to ask for the abolition of the technique of taxonomists. To submit to rules of nomenclature "to the plenum of the congress to vote," is to destroy all possibility of taxonomic technique. The botanists have already furnished the awful example. Rules which no investigator can or will follow or which may be set aside in the interest of choice or convenience do not contribute to the fixity of nomenclature.

As to the specific propositions quoted by Dr. Kingsley:

1. To exempt a list of names "in common use before 1900" or "employed in instruction."

It is hard to see by what authority this can be done and the list made permanent. Taking individual cases: *Echidna* is the name of a large and widely distributed genus of eels as well of the Australian spiny monotreme, the eel-name having been in use 140 years. Why should the ichthyologist give it up? As to *Amia,* it is a pity that Linnæus chose that name for the ganoid bowfin when Gronow had used it five years before for a perch-like fish. Personally I preferred to reject all Gronow's

non-binomial generic names, leaving *Amia* instead of *Amiatus* for the bowfin, but I follow the decisions of my colleagues. We can not use the same name for two genera. The list of genera, the retention of which is desired as printed in SCIENCE, contains 38 names, the changing of most of which has been unpleasant to taxonomists as well as to others. But these 38 we would like to keep are very few among the thousands of generic names which only a recognition of the law of priority and of some law for fixing the type of incongruous genera can hope to regulate.

The second proposed rule is this:

> The transfer of generic or specific names from one genus or species to another shall not be allowed when this will lead to lasting confusion or error.

This reads fairly, but it is not possible to give it definite application. Some names occur so frequently in literature that they may be said to be definitely fixed. Most names the world over have only a tentative status. The fauna of the world is very large, and we are only at the beginning of our knowledge of it. The fauna of western Europe, to which many of the 38 names belong, is only a minute fragment of it. The main source of confusion and error is, however, in leaving a name where it does not belong, after its right place or right usage has been made clear. But if this rule could be lucidly framed so as to permit regularity of application, it has its merits.

The third proposition, the rejection of certain authors on their merits as non-binomial, has its advantages. The non-binomial writings of Brisson and Gronow have been accepted by the commission. A non-binomial condensed reprint of Klein has been rejected. Either view of the case, if generally followed, leads to stability. Before the ruling of the commission Brisson's names were accepted by a majority, those of Gronow, on the same footing, by a minority. The commission has voted to accept both. The matter is likely to come up again at the Monaco meeting.

The fourth proposition, the rejection of non-scientific catalogues, newspapers and the like, might be reasonable if it could be properly defined.

The vital thing is the recognition of law as superior to personal preference or temporary convenience. The "deplorable results" of adherence to the rigid rule of priority are as a drop in the bucket compared to the "deplorable results" that have followed the go-as-you-please acceptance, rejection or change of generic and specific names. And this latter form of "deplorable results" does not trouble the non-systematist who uses scientific names casually as labels for his preparations or who may deal with a small part of a long-known fauna. They vex the systematist who must map out and record some broad part of the vast system of the life of the globe. In his bookkeeping he must follow the same methods throughout regardless of local usage or of personal preferences.

DAVID STARR JORDAN

THE PHYSIOLOGICAL SIGNIFICANCE OF THE SEGMENTED STRUCTURE OF STRIATED MUSCLE

TO THE EDITOR OF SCIENCE: In my article, "The Physiological Significance of the Segmented Structure of Striated Muscle," published in your issue of August 23, I make, on page 251, the following criticism of certain current hypotheses of muscular contraction:

> A further disadvantage of the "swelling-hypotheses"—as contrasted with the surface-tension hypothesis—is that they offer no suggestion as to the nature of the connection between the electrical variation accompanying contraction and the contractile process itself.

Some qualification of this statement is now necessary. In Pauli's recent article, "Kolloidchemie der Muskelkontraktion" (Th. Steinkopff, 1912), which has reached me since my article was printed, an attempt is made to refer the negative variation to the formation of acid-protein compounds within the muscle-cell. Such compounds would yield on dissociation mobile anions, *e. g.*, lactate ions, and immobile or colloidal cations. On the assumption of a free permeability of the plasma-membrane to these anions, the formation of such compounds would theoretically give rise to a negative variation. But this conception appears to me insufficient to account for the entire phenomena of action and demarcation

currents. In particular, it fails to take into account the relations known to exist between the general permeability of the plasma membrane and the demarcation-current potential. Evidence from many sides shows that this potential varies with the permeability of the plasma membrane to simple crystalloid substances, decreasing as this permeability increases. All cytolytic (*i. e.*, permeability-increasing or membranolytic) substances and processes, so far as known, diminish this potential. Such facts indicate very clearly that semi-permeable membranes form a fundamental if not the chief factor in the production of the demarcation-current potential, and hence also in the production of the action-current which is evidently due to a variation in this potential. Any sufficient reversible increase in permeability would produce under these conditions a negative variation. Obviously, numerical data are required for a decision of those questions. It is not unlikely that several distinct factors are involved in the production of the action-current, and that the observed effect is an additive one. The potential of the action-current is said often to exceed that of the demarcation-current, a fact inexplicable on the simple membrane theory. But if an electrical variation due to a chemical change of the kind imagined by Pauli were superposed on one due to altered membrane-permeability, such an effect might conceivably result.

Ralph S. Lillie
Marine Biological Laboratory,
September 1, 1912

SCIENTIFIC BOOKS

Physik in graphischen Darstellungen. Von Felix Auerbach. Leipzig, B. G. Teubner. 1912. Large 8vo.

In recent years Professor Auerbach has been devoting himself, with success, to encyclopedic treatises on physics. It is not so long since he published his excellent "Kanon der Physik." But the present book is decidedly more novel in design. It will, in particular, be invaluable to teachers. It lends itself at once to the construction of lantern slides for the graphic illustration of involved points in theory. It is furthermore an aid to the setting of graphic problems in all parts of the subject. In a lecture course on light, for instance, almost all the answers to questions can be given by graphs. Such an exercise is easily corrected on the one hand, while on the other it is exceedingly difficult for the student to answer the question by mere copying. It has therefore always seemed to the writer that a similar body of questions, carried throughout the whole of physics, all of them to be answered graphically, would meet many of the difficulties now encountered in case of a lecture course. It is probable that Auerbach's book is a definite contribution in this direction and that a systematic course of questions, to be answered by drawing, may be put together by means of it.

Among the great variety of diagrams and constructions given, all of about the same importance, it will only be possible to refer to a few at random. Thus the curious representation of dimensional formulæ obtained by laying off the powers of c, g, s, in terms of length, breadth and thickness, is new to the writer. Graphic classification of different orders of standard magnitude in physics, as, for instance, the prominent distances, times, velocities, densities, etc., occurring in mechanics and the vast number of data in other parts of physics, are bound to be convenient for reference. Constructions relating to equipotential surfaces and lines of force are given in familiar diagrams, but the plates contain suggestive cases of graphic statics, including standard trusses. Similarly the velocity and acceleration hodographs adduced are cleverly chosen. The representation of the cylindroid, however, seems to the writer inadequate.

The subject of elastics both on its experimental and theoretical side lends itself admirably to graphic treatment, and a great variety of constructions is given, including impact, viscosity, hardness, etc. In hydrodynamics the plates abound in practical applications of the subject, in addition to the many exhibits of flow for cases of both rotational and irrotational motion. Waves are particularly well illustrated and the final develop-

ment of the subject embraces the molecular properties of liquids. The kinematics of harmonic motion is reproduced by an extensive collection of typical cases, after which follows a very full treatment of the graphics of acoustics. The information which is here brought together is extraordinarily rich.

Thermal phenomena are now so extensively known that the graphic method seems almost necessary for their classification. Particularly in the broad subject of solution such a method seems to be the only one adequately available and Auerbach has made full use of it.

The diagrams in electricity are as a rule more familiar, though Auerbach has not failed to introduce much of the recent progress, as in radiology, for instance. Finally, in the section of optics he has had the advantage of long residence in Jena. Throughout the book, in fact, the charts relating to the properties of the Jena glasses are very satisfactory. At the same time the progress there made in optical theory is fully recorded.

The book contains 213 pages and on the average three or four graphs to the page. It concludes with a brief description of the charts together with the necessary bibliographical notes and an index. The charts are throughout up to date, both in their theoretical and experimental references. In looking them over one obtains, perhaps, a more vivid impression of the noble accomplishments of modern physics than can be given by any other method.

CARL BARUS

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How to Use the Microscope, a Guide for the Novice. By the Rev. CHARLES A. HALL. 25 text-figures and 20 full-page plates. London, Adam & Charles Black; New York, The Macmillan Company. 75 cents net.

The purpose of this book is well expressed by the author when he says: "It is a guide for the novice, and I have not presumed to offer advice to the expert microscopist." The seven chapters of the book limit themselves to what the novice can really do to start with in microscopic work. Once fairly started, the world is all before him.

In Chapter I. the simple microscope, its advantages and use, are described, and what is said is wholly commendable. In the second chapter there is a discussion of the compound microscope, and the author tells from his own experience how any one can construct a compound microscope. In the third chapter is a general discussion of the use of the compound microscope and the excellent advice given to learn the advantages of low powers. The fourth chapter tells of some important accessories like the substage condenser and the polariscope and the stage micrometer. Coming to the fifth chapter, the real work begins with some common objects for microscopic study. The student is shown where to find them in ponds and ditches, in rock pools of the sea, in the flower pots of the home, in the garden and fields and in the great insect world. He is directed how to prepare and study the things collected, and good books are mentioned which will give fuller information.

In the sixth chapter directions are given for preparing objects and mounting them permanently. This includes mounting objects dry, mounting insects whole in balsam, making sections of plant tissues, staining and mounting them; and finally the making and mounting of rock sections. The seventh and last chapter deals with the method of making photographs of microscopic objects, and the examples of photomicrographs by the author which illustrate his book furnish excellent models.

A critical reading of the book shows that it is unusually free from errors. Its advice is good and one feels sure that it comes from one who has been over the ground many times and has learned the good ways. It seems admirably adapted for the beginner in England. For the beginner in any other country it is not so well adapted, as it tells only of the optical goods, etc., to be had of the London opticians, and the beginner would naturally suppose that he must have the identical things mentioned, at any rate he would know of no

others, and the book gives information of no other place for getting them. The American novice, for example, would have no information concerning the excellent optical houses in his own country which supply exactly what is needed; and all worry about the British "methylated spirits" might easily be avoided by explaining that ordinary alcohol or "denatured" alcohol would answer equally well.

It would be so easy to adapt a fundamentally good book of this kind to the country where it is to be introduced that it seems incomprehensible why publishers are not more awake to the advantages of such adaptation.

These suggestions are made in the most friendly spirit, and with the hope that future editions will be made the most useful possible in the new environment; for certainly no one at all familiar with the subject could read these 86 delightful pages, so full of helpful suggestions to the beginner, and so full of enthusiasm for the beautiful world which the microscope reveals, without a feeling of gratitude to the author for making so plain the way into this new realm, for uncovering a road which has no end and which has new beauties for each advancing step.

S. H. G.

The Polynesian Wanderings. Tracks of the Migration Deduced from an Examination of the Proto-Samoan Content of Efate and other Languages of Melanesia. By William Churchill. The Carnegie Institution of Washington. 1911. Pp. 516, 2 maps.

The wanderings of the Polynesians have long been a fascinating crux in ethnology. The peopling of an inconceivably vast area sprinkled with islands appeals to our wonder more than the settling of continents, and from the time of the earliest explorers in the Pacific attempts have been made to hit upon some clew to the dissemination of oceanic peoples. It early appeared that language afforded the best means of tracing these movements and in the gross this index has been used since the time of Hale by students of the Pacific insular races.

Philology has made great strides both materially and scientifically in recent years, however, and Mr. Churchill is foremost among those who have applied the analysis of the content of a language to the solution of the historical problems connected with the migratory movements of peoples, his method in this case being to ascertain the percentage of Proto-Samoan loan words in the Melanesian languages over the area in question and to chart the lines of migrations of the Polynesians along the lines of greatest percentage. The method thus establishes a definite quantitative basis of language research, the results of which are very gratifying.

Mr. Churchill has shown by his percentage measure that the Proto-Samoans emerged from the East Indies, passed out into the Pacific, and with various Melanesian landfalls, reached Samoa, regarded as the primary distributing focus of Polynesians, thence by diverse routes, populating other islands, and in turn streaming from several foci, completing the population of the islands where we now find Polynesians. The earliest movement, according to Mr. Churchill, appears to have taken place about 1,500 years ago.

Among its other valuable qualifications the work is a remarkable analysis of an archaic language which Mr Churchill hopes will supply the data for the genesis of speech. This, Mr. Churchill modestly puts forward as the feature of his monumental book which will give it a continued and wide influence.

The Carnegie Institution is to be congratulated on the publication.

Two maps accompany the work, the one showing the tracks of Polynesian migration and the other the migration tracks through Melanesia.

There are three appendices, one containing data and notes, two, the southern gateway, and three, a bibliography. An adequate index is supplied.

Walter Hough

CHANGES IN THE GERMAN UNIVERSITIES

The former student returning to Germany finds many changes. In the development of the new Germany from the old, much that was familiar has disappeared or has been replaced

by institutions of a different type. And although the universities have altered less than the nation at large, and the national culture, they too have felt the influence of the years. In particular, the distinction between the city and the country universities has become more marked with the surprising growth of the cities themselves. This holds especially of Berlin. The old university building there remains outwardly the same—one of the few reminders in the present capital of the city we used to know. Only the statues of Helmholtz, of Mommsen, and of Treitschke, by the entrance, suggest that earlier days, and the former giants, have departed. But in other respects there are many changes. The student body has enormously increased, numbering in the last winter semester, if the *Hörer* be included, more than ten thousand souls. And such numbers create new problems of themselves. Class-rooms and laboratories grow crowded: in the summer semester of this year the Philosophical Seminary at Berlin had thirty-five members and sixty-five *Zuhörer*—a *Publicum* almost in itself. And professors are borne down by the burden of their varied engagements, rather than by the pressure of their normal work. But even this army is swallowed up in the metropolis into which Berlin has grown. Did we a generation ago fill so small a place in the life of the city? Perhaps, in the pride of youth, we exaggerated our importance, but it seems hardly possible that we were so little in evidence as the students of to-day. In any case, it is certain that we found conditions then more easily adaptable to the needs of our academic life. The old Berlin student could live reasonably near the university; now, like his professors, he must seek residence remote from the costly center of the town. Not only the price of his lodgings, but his other expenses have increased. About him, also, he finds a more commercial environment, one less in harmony with the spirit of his work. The rush, the roar, the distractions, the temptations of the city force themselves upon his notice in new, it may be unpleasant, ways. In spite of "Amerika Houses" and the several lines of communication between the university and our own institutions, the student far from home encounters problems less familiar, and more grave, than those which his predecessors had to face.

Within the universities, on the other hand, the student of to-day enjoys comforts which our generation lacked. Throughout Germany progress has been made in adapting the conditions of study to the standards of the times. New *Collegien Haüser* have been erected, for example the fine academic center at Jena. Libraries have been built on modern lines, as at Freiburg i. Br. and Berlin. New seminaries, laboratories and clinics have been completed or projected—so just now in Heidelberg one sees the extensive plans for the enlargement of this phase of the university's equipment. And the older quarters have been improved somewhat into modern forms. The change is welcome, even if to our judgment incomplete. For nothing restores one's feeling of acquaintance so quickly as an hour's attendance at a university lecture. In the fine new buildings the rooms seem designed on the familiar lines, the benches and the desks remain, in shape at least, unchanged. As of yore, they cramp the listener's body as much as his mind is expanded by the wisdom which he hears.

The students who throng the precincts of the universities seem familiar, and yet altered. Their comparative youthfulness may be ascribed to a subjective, rather than an objective change. But in certain ways the students of the present generation give real occasion for surprise. They come late to lectures—at least we noticed it in Heidelberg and Berlin—as public sentiment would never have permitted them to do in earlier days. They discriminate in their note-taking, even to the point of shorthand abstracts, whereas it was part of the old dogmatic faith so far as possible to record every word which fell from the lecturer's lips. Strangest of all to the returning veteran is the presence of women. Co-education, at least in the east of the United States, is dying out, we told our German friends. "But why? Our experience is different," came the answer—a reply which

corresponded to the evident facts of the case. Not only is the new arrangement established, it appears, as again the Germans themselves witness, to be working with success. Statistics show the attendance, winter semester, 1911–12, of about one woman for every twenty male students in the universities, taking Germany as a whole. Except that, between hours, you see not a few pairs wandering *friedlich mit einander,* the women, further, seem to be accepted on the same footing as the men, and to feel themselves so situated. If some lecturers have enlarged the traditional formula of address into *meine Herren und Damen,* others are more polite and greet the ladies first. The only doubt we heard expressed was whether a woman is fitted by her physique to meet the demands of the highest university education. The majority of the women students, we were told, are planning to become teachers or physicians. Will they be able through the years to support the strain?

One negative experience on a visit to several of the leading universities was unexpected, the failure to meet students of English speech, in particular students from our own country. In Berlin we did meet one or two young Englishmen as they came from lecture; and one American professor was *hospitanting* like ourselves. In Munich we renewed delightful acquaintance with a former pupil working for an advanced degree. Of course, there must have been many others whose paths did not cross our own, and in the summer semester the number of Americans is normally smaller than in winter. But they seem relatively fewer than of old, and the records appear to bear out the observation. For the winter semester, 1911–12, out of 57,398 matriculates in all Germany, 338 is the total number assigned to *Amerika,* under which no doubt our countrymen formed the most considerable part. And if this be compared with the statistics of former years, it will be seen that the number of American students has increased but slowly.[1] The

[1] Beginning with the winter semester, 1904–05 (when first the statistics were given in the *Deutscher Universitäts-Kalender*) the record is as follows:

Semester	Matriculates	From America
Winter '04–'05	39,719	295
Summer '05	41,533	259
Winter '05–'06	42,051	298
Summer '06	44,964	274
Winter '06–'07	45,136	302
Summer '07	46,655	261
Winter '07–'08	46,471	304
Summer '08	47,799	252
Winter '08–'09	48,717	333
Summer '09	51,500	298
Winter '09–'10	52,407	332
Summer '10	54,393	298
Winter '10–'11	54,823	398
Summer '11	57,200	292
Winter '11–'12	57,398	338

change gives ground at once for satisfaction and regret. That opportunities for advanced training at home have so developed that there is less relative need for foreign travel, is surely ground for satisfaction. If we are really losing, as appears to be the case, the enlargement which a generation or two ago came to many of our most promising younger scholars through their residence abroad, it is a loss which will make itself felt. In spite of the unquestioned value of German scholarship, it was not always that we learned as much as we had expected in the lecture rooms, or in the seminaries themselves. But many of us gained vastly more than we had hoped from our life in a foreign land and acquaintance with continental culture. Especially was this true of the students of the "humanities." The exact sciences derive less from environment and the "intellectual climate." But the historian, the economist, the sociologist, the philosopher, the theologian, even the student of literature, if he be more than a "philologer" of the drier type, is confronted by a dilemma. He remains provincial, or he must live himself into the thought of the world. This he will rarely do with full success unless he shall have shared in foreign culture by personal contact. And the foundations of his sympathy are best laid in his "post-graduate" years.

Of things American, on the contrary, and of American scholarship, much more is heard to-day than formerly. The system of "ex-

change-professors," "Amerika Houses," and the like is familiar. Even more noteworthy this spring was the attention given to the work of American scholars. At least, this was noticeable in the writer's department of philosophy. At Erlangen, Falckenberg had recently granted a doctorate based on the study of Dewey's pragmatism. In Heidelberg, Troeltsch, beginning his course on the philosophy of religion "for members of all faculties," was discussing pragmatism (as well as the work of the English anthropologists). In Jena, Eucken's "Uebungen" were based on Wobbermin's translation of James's "Varieties of Religious Experience." It would be too much to say that this interest in recent phases of our thinking always indicates agreement. One rather gathers the impression from German scholars that the pragmatic philosophy is not gaining, but losing ground. But it was an agreeable reminder that the scholars and the scholarship of the two nations have come into closer touch. Our indebtedness to the German universities is large. And for some time yet we will continue, if we are wise, to increase our obligations, accepting more than we attempt to give in return. But it was not unwelcome to discover that some beginning of repayment had been made.

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SPECIAL ARTICLES

ANOTHER VIEW OF SEX-LIMITED INHERITANCE

AMONG results which were obtained by the writer during several years of work in crossing blond ring-doves (*Turtur risorius*) with white ring-doves (*T. alba*), was sex-limited inheritance. When the male bird is white, *i. e.*, recessive, the offspring in F_1 are about equally white or blond like one parent or the other, and the white birds are *all females*. By the reciprocal cross, all of the F_1 offspring are blonds like the male parent.

The blond and the white ring-doves may be distinguished by a group of characters which behave apparently as a unit, so that a simple formula may be used to represent the situation. The white ring-dove differs from the blond bird as follows: (1) melanin pigment is almost entirely absent in the feathers; (2) there is little of this pigment in the skin; and (3) the eyes contain extremely little melanin pigment except in the iris region. In other words, the dominant characters of the blond bird are represented in the white dove in an extremely dilute or very slightly developed form, but they are not entirely absent. Their appearance suggests strongly the idea that development has been arrested.

The late Professor Whitman obtained white females in F_1, when white male ring-doves were crossed with females of the very different species, *Turtur humilis*. This result is mentioned by Bateson.[1] A similar result has been described by Staples-Browne[2] for a cross between a male white ring-dove and females of another very different species, *Turtur turtur*.

A number of other cases as well as these have the common characteristic that recessive F_1 offspring appear when the male parent is recessive, and these individuals are always females. Dominant characters are borne by the F_1 males and sometimes by F_1 females. Thus, two dominant females were obtained by Durham and Marryat[3] with canaries and two by the writer with ring-doves, in crossing recessive males with dominant females.

Cases of sex-limited inheritance which have occurred in animals, and especially with birds, have been interpreted by Spillman,[4] Bateson[5] and others with the following as-

[1] Bateson, "Mendel's Principles of Heredity," University Press, Cambridge, England, 1909, p. 194.

[2] Staples-Browne, "Second Report on the Inheritance of Color in Pigeons, together with an Account of some Experiments on the Crossing of certain Races of Doves, with special reference to Sex-limited Inheritance," *Jr. Genetics*, 1912, Vol. 2, No. 2, pp. 131–162, plates VI.–IX.

[3] Durham and Marryat, "Note on the Inheritance of Sex in Canaries," Report to the Evolution Committee, Roy. Soc., 1909, IV., pp. 57–60.

[4] Spillman, "Spurious Allelomorphism: Results of Recent Investigations," *Am. Nat.*, Vol. 42, 1909, pp. 610–615.

[5] Bateson, "Mendel's Principles of Heredity," University Press, Cambridge, England, 1909, 396 pages.

sumptions: (1) that the male is homozygous for sex and the female heterozygous; and (2) that a "spurious allelomorphism" may exist with the consequence that certain sex and somatic factors may not be present in the same gamete.

These two assumptions are unnecessary if the cytological evidence that male and female determining sperms are produced by the male is regarded. The eggs may then be considered to be all alike. The appearance of recessive females in F_1 may then be explained with the assumption that the female-determining sperms of the recessive male parent may suppress the development of dominant characters in the resulting zygote, or it may be assumed that these sperms lack something which is necessary to the proper development of the dominant characters even when the female parent bears them. Whether this suppressing power or the lack of something necessary for the development of dominant characters is connected with an accessory chromosome or not, is not essential to the assumption.

In the formulæ which follow, the characters of the blond ring-dove are designated by B and those of the white bird by W. Female-determining sperms are distinguished by a subscript $_f$ with an additional $_w$ in the case of those which are produced by the white (recessive) male. It seems more appropriate, and less confusing, also, to call all sperms male and all eggs female, whether two kinds of either exist or not, instead of using the signs of both sexes, as is done commonly, for the gametes of the sex which is considered to be heterozygous. Characters which are recessive to others, in the same individual, are included in parentheses.

1. Blond ring-dove males × White ring-dove females.

composition

$B♂\,B(♀)$ — $W♀\,W(♂)$

producing gametes $\{ B♂ \; B_f♂ \}$ — all $W♀$

result: Blonds, mostly males $B♂\,(W♀)$ — Blond females, a few. $B♀\,(W♂)$

2. White ring-dove males × Blond ring-dove females.

composition

$W♂\,W(♀)$ — $B♀\,B(♂)$

producing gametes $\{ W♂ \; W_{fw}♂ \}$ — all $B♀$

result: Blond males $B♂\,(W♀)$ — White females $W_w♀\,B(♂)$ becoming $W♀\,W(♂)$ through presence of condition indicated by subscript $_w$.

Blond females, occasionally, through absence of $_w$ effect.

As the white F_1 hybrids were all females, it was not possible to breed white hybrids *inter se*. When these white hybrids were crossed back on stock white males, only white offspring were obtained, and they were found to be so-called extracted recessives.

3. Blond F_1 hybrid ring-dove males × White ring-dove females.

composition

$B♂\,(W♀)$ — $W♀\,W(♂)$

producing gametes $\{ B♂ \; B_f♂ \; W♂ \; W_{fw}♂ \}$ — all $W♀$

result: Blond males $B♂\,(W♀)$ — Blond females $B♀\,(W♂)$

White males $W♂\,W(♀)$ — White females $W♀\,W(♂)$

4. Blond F_1 ring-dove hybrid males × Blond ring-dove females.

composition

$B♂\,(W♀)$ — $B♀\,B(♂)$

producing gametes $\{ B♂ \; B_f♂ \; W♂ \; W_{fw}♂ \}$ — all $B♀$

result: Blond males $B♂\,B(♀)$ and also $B♂\,(W♀)$ — Blond females $B♀\,B(♂)$

White females $B♀\,W_{fw}(♂)$ becoming $W♀\,W(♂)$ through presence of condition indicated by subscript $_w$.

Only two successful matings of blond hybrid F_1 ring-doves *inter se* were made, as blond hybrid females were seldom obtained. The expectation for such a cross is given in the following formula. Males and females of both colors were obtained, but their composition was not tested.

5. Blond F_1 hybrid males	×	Blond F_1 hybrid females.
composition		
$B♂ (W♀)$		$B♀ (W♂)$
producing gametes $B♂$		
producing gametes $B_{tw}♂$		$B♀$
producing gametes $W♂$		$W♀$
producing gametes $W_{tw}♂$		
result: Blond males		Blond females
$B♂ B(♀)$		$B♀ B(♂)$
and also		and also
$B♂ (W♀)$		$B♀ (W♂)$
White males		White females
$W♂ W(♀)$		$W♀ W(♂)$ and also $B♀ W_w(♂)$ or $W♀ W(♂)$

A more detailed description of the results which were obtained by the writer in crossing ring-doves has been prepared for publication, and a preliminary statement[6] has appeared in this journal.

The interesting results, recently described by Cole,[7] are easily explained by this scheme when we recognize that yellow, dun, red, etc., in pigeons are due essentially to less intense melanin pigmentations than that which is represented in black. The dun females in both of Cole's "Cases I. and II.," would then be due to conditions in the female-determining sperms of the recessive male (designated by subscript $_{tw}$ in the formula used in this article). The occurrence of red, yellow and dun in the offspring from the reciprocal cross is not surprising when the uncertain purity of domestic-pigeon stock is considered. Durham and Marryat compared their canaries on the basis of eye-color, as the numerous color variations of the plumage were less satisfactory characters.

R. M. STRONG

[6] SCIENCE, N. S., Vol. 33, p. 266, 1911.
[7] SCIENCE, N. S., Vol. 37, pp. 190–192.

FURTHER NOTE ON THE RESULTS OF OVARIOTOMY ON DUCKS

ON July 26 of the present year, one of the ducks (No. 24, now three years old) on which ovariotomy had been performed as recounted in the *Biological Bulletin*, Vol. XX., No. 1, 1910, was killed and dissected. In my original report I stated simply that the bird was castrated, but made no statement concerning the completeness of the ovaries' removal. It is the purpose of this note to supply this lack. But before proceeding to describe the results of the autopsy, certain points should be briefly reviewed.

August 13, 1909, the *left* ovary was removed, no attempt being made to remove the right gonad, which it was assumed had completely degenerated. The duck was then 12 weeks old and already had the secondary sexual characters of the female which are distinct from those of the young male. For nearly a year afterwards this bird passed as an ordinary female. Then it was observed that a part of her feathers were like those of a male. At a moult soon after, she assumed still more of the male's characters, being in the condition shown in Fig. 11 of my earlier report. Subsequently, still more of the male's characters were acquired until her plumage was predominately, yet incompletely, male. For the last 18 months or so the plumage has remained in this intermediate condition, though several moults have occurred in the meantime.

At the autopsy no trace of an ovary on either side could be found. The only duct present was a well-developed but juvenile oviduct on the left side.

The other duck (No. 4), described in the paper referred to above, was examined through an opening in the left side on August 22. The site of the ovary was empty except for a thin strand of connective tissue. As far as could be seen from the left, the right side also was completely empty. This duck, operated on when nearly a year old, had laid several eggs in the period immediately preceding the operation. One was removed from the oviduct at the operation. She has developed only

a comparatively few feathers exactly like those of the male in full breeding plumage, the majority resembling, rather, those of the male in summer plumage.

In each of these cases, then, removal of the ovary has been followed by a greater or less assumption of male characters.

Further light on the subject may be expected in due course from the birds on which ovariotomy has been performed this season, several already having feathers like those of a normal male.

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Note on a Method of Mimicking Amœboid Motion and Protoplasmic Streaming in the Same Model[1]

The following method of mimicking amœboid motion and protoplasmic streaming has been employed by me for class-demonstrations during the past five years. As it is extremely simple and yields results which are very striking and instructive, it appears advisable to communicate it to a wider public.

It is well known that if particles of camphor be dropped upon the surface of clean water they display energetic movements which are attributed to large and unequally distributed alterations in the superficial tension of the air-water surface at points of contact with the camphor.[2] It occurred to me, therefore, that if camphor could be incorporated into a fluid immiscible with water, drops of the mixture placed upon water might be expected to display surface deformations resembling those occurring in the formation of pseudopodia. This anticipation proved correct.

I prepare a ten-per-cent. solution of camphor-gum in benzol and then, since drops of this water-white liquid are difficult to observe upon the surface of water, I color it deeply by the addition of Sudan III or Scharlach R. If a drop of this mixture be placed upon the surface of water, violent and extremely rapid deformations of surface are observed. Lengthy and irregular "pseudopodia" are rapidly thrown out and withdrawn. The whole drop exhibits a veritable ecstasy of motion which shortly ceases when a fine incrustation of precipitated camphor has spread over the water.

By successive additions of some viscous liquid such as olive oil to the mixture the motions of the drops can be rendered slower and slower and more readily followed in detail by the eye. When at length a mixture is formed of equal volumes of olive oil and the camphor-benzol solution the formation of "pseudopodia" is no longer observed; instead, we observe a prolonged and energetic streaming movement within the drop which mimics in the closest manner imaginable the phenomenon of protoplasmic streaming.

In this way the modifying influence of viscosity upon the reaction of fluid masses to local changes in superficial tension can be shown in any desired gradation; it appears probable that a superficial semi-solid pellicle must restrain the movement of the fluid in much the same way as internal friction. Hence, the phenomena of protoplasmic streaming and amœboid motion are readily traced to the same origin.

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[1] From the Rudolph Spreckels Physiological Laboratory of the University of California.

[2] Van der Mensbrugghe, cited after Rayleigh, *Proc. Roy. Soc. London*, 47, 1890, p. 64.

The Dundee Meeting of the British Association for the Advancement of Science[1]

The meeting of the British Association at Dundee which has just come to an end will be remembered as one of the pleasantest and most successful in the annals of the association. It was thought to be impossible to surpass the number of members and associates who attended the last Dundee meeting, just 45 years ago; indeed, it was not expected that so high a figure would be reached. But the number this year—2,504—is considerably in excess of the total in 1867, and the support accorded to the association by every one in Dundee, from Lord Provost Urquhart to the humblest citizen, has been most gratifying.

[1] From the London *Times*.

Public and private hospitality have been lavished on the visitors, and nothing that could contribute to their comfort and pleasure has been left undone. The organization has been admirable, and the very heavy work entailed on the honorable local secretaries, Professor D'Arcy Thompson, C.B., Dr. A. H. Millar, and the Town Clerk, Mr. W. H. Blyth Martin, has been carried out without a hitch. The history of these meetings proves that their success depends in a very large measure on the local secretaries, and a generous meed of praise is due to those in Dundee for their untiring efforts on this occasion.

The people of Dundee, moreover, realized the fact, not always present to the minds of the citizens of places visited by the association, that they are most heartily welcome at its meetings, and the way in which they flocked to the reception rooms to take out their tickets rejoiced the hearts of the president and his supporters. If further evidence is needed of the warmth of Dundee's welcome it is to be found in the munificent donation of £10,000 made by Dr. Caird, a distinguished citizen, to the funds of the association. This noble gift, unfettered by conditions, was handed in the form of a check to the president, Professor Schäfer, at the conclusion of his opening address. Of this address, which dealt with the problem of the origin of life, it is unnecessary to speak in detail, since it has been reported fully in *The Times*, and has attracted widespread attention. The origin of life also formed the subject of a discussion between the Zoology and Botany Sections. This was one of the principal features of the meeting, and attracted an audience so large as to necessitate the hiring of a special hall for its accommodation. The social program, arranged and carried out with complete success, comprised a civic reception, a splendid ball, and garden parties, flower shows, and excursions far too numerous for individual mention. The admirable evening discourses by Professor W. H. Bragg, F.R.S., on "Radiations Old and New," and by Professor A. Keith, on "The Antiquity of Man," were attended by crowded audiences; and there were besides three lectures for working men, one by Professor Fowler on the Sun, another by Professor Gonner on Prices and Wages, and the third by Professor B. Moore on Science and National Health, all of which were practical, informing and well attended. A brief summary of the work in the various sections is given below, though it must be understood that it is not possible to cover so wide a field exhaustively.

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

Interest in this section centered chiefly in the discussion on wireless telegraphy, when Sections A and G (Engineering) joined forces. From many points of view this discussion was one of the most important features of the Dundee meeting. Contrary to the usual custom, practical achievements were almost disregarded and there was a total absence of those sensational announcements which have tended to become characteristic of public discussions on wireless telegraphy. So far as a section of the public is concerned this may have been unfortunate, but it was welcomed by many of the engineers and physicists present. The points discussed were: the "bending" of the waves to follow the contour of the earth, and the so-called "day-light effect," which makes it possible to transmit signals for a very much greater distance by night than by day, using the same power. Several distinguished physicists and electricians took part in the discussion, among them being Lord Rayleigh, Professor Fleming, Professor S. P. Thompson, Dr. W. H. Eccles and Professor Howe.

Much time was devoted to papers on general physics and mathematics. An interesting discussion took place on the atomic heat of solids, in which Section B also joined. The opening remarks were made by Dr. F. A. Lindemann. On more than one occasion when the section divided into two parts, that part which dealt with general physics fell completely into the hands of the radioactivity enthusiasts, and some excellent papers and discussions resulted. For example, Professor J. C. M'Lennan succeeded in convincing the majority of his audience that the earth's radiation is practically constant and does not suffer any diurnal or other variation. It was interesting to observe also that some attention is being paid to such matters as the velocity and direction of the wind above ground level, and the temperature of the upper atmosphere, for these things must of necessity have considerable bearing on aviation problems.

SECTION B—CHEMISTRY

The proceedings of this section have been spoken of as highly technical in character, but the problems which chemists are now engaged in studying are of a far more fundamental character and far more closely related to the affairs of life than those of most other sections. Theirs is the task of unravelling some of the mysteries on which the president of the association dwelt at length in the opening address, and by some it is held that it will rest with the chemists eventually

to say what living matter is and what may have been the origin of life. Two of the sittings were largely devoted to work of this kind. On Friday, when the chemists and botanists combined forces, the papers read mostly had reference to important problems in plant chemistry. On Monday Professor Irvine, of St. Andrews, gave an account of researches on which he has long been engaged, which are throwing much light on the nature of the sugars—a class of substances which play an all-important part in plant life and as animal foods. Again the final sitting was devoted to papers dealing with the mechanism of chemical change, a problem which is fundamental for the understanding of the processes both of organic and of inorganic nature. Other communications dealt with topics of physical interest.

SECTION C—GEOLOGY

The address of the president, Dr. B. W. Peach, was a welcome résumé of the paleontological evidence with regard to the fauna of the Cambrian rocks of the British Isles as compared with that of North America. The interesting problems of the Highlands gave rise to several valuable papers and addresses. Dr. Robert Campbell described the discovery of fossils in the jasper and green schists of the Highland Border near Stonehaven. This is of great interest, as it proves that the beds are not pre-Cambrian, but of Upper Cambrian or Ordovician age. Dr. Jehu supplemented this by an account of fossils recently found in the Boundary Fault series, near Aberfoyle, by which these beds are identified as of Upper Cambrian age.

Dr. Campbell also described an important discovery of the Downtonian (Silurian) Age of certain beds between Craigeven Bay and Stonehaven Harbor, which was formerly classed as Old Red. *Dictyocaris* is abundant, and *Ceratiocaris* is also found. These fossils have never been found elsewhere in rocks younger than the Silurian. Interesting results of the examination of pebbles from the Millstone Grit of Yorkshire were given by Mr. Albert Gilligan, of Leeds University. Large numbers of these pebbles have been collected and sliced, and give evidence of derivation from Scottish or Norwegian sources. Mr. Gilligan has been impressed by the many points of similarity existing between the Millstone Grit and the Torridon Sandstone, and is disposed to think that areas of similar rock types were laid under contribution for each. Dr. J. D. Falconer described the detached hills of South Africa, which possess caps of weathered rock which he attributes to the effect of periods of elevation and erosion following upon periods of decomposition at base-level.

SECTION D—ZOOLOGY

The meeting of this section was undoubtedly one of the most successful ever held. This was due to various contributory causes—to the number and interest of the communications, to the large attendance of British and foreign zoologists present, and in no small degree to the fact that one of the two indefatigable local secretaries is a zoologist of distinction. Two inter-sectional debates were held, one with the Section of Physiology and the other with the botanists. The subject of the former was upon the nutrition of marine organisms. Professor Pütter, of Bonn, was present and opened the discussion with an account of his own work, which he claims furnishes proof of the ability of marine organisms to obtain nourishment from organic solutions present in sea-water. The discussion was animated and well sustained, though it must be admitted Professor Pütter's views found but few adherents. The discussion on the Origin of Life was opened by Professor Minchin. The largeness of the audience was no doubt in great part due to the fact that Professor Schäfer in his opening address had dealt with the same subject. The debate was interesting, and the discussion of such a subject is valuable in the way of "stocktaking," but a final solution is still far remote.

A new departure at this year's meeting was an exhibition of zoological specimens and methods. This was extremely interesting and attracted much attention, especially the demonstration by Professor Leduc of his well-known diffusion figures. It is to be hoped that such an exhibition will become an annual feature and that in future time will be allowed for people to examine it more carefully; an afternoon session should be entirely given up for demonstrations. As a result of the advocacy by the president of the section, Dr. Chalmers Mitchell, of the preservation of wild animals other than those of sporting or economic value, the sectional committee forwarded a resolution to the council of the association drawing attention to the urgency of the matter.

Of the morphological papers perhaps that of Professor Julin on the luminous cells of certain tunicates was the most appreciated. Accounts were given of the work being done at Aberdeen University upon the migration of birds and an inquiry into the food of birds, the latter subject

being one of great economic importance. These experiments need to be extended over a period of years before any certain conclusions can be drawn.

SECTION E—GEOGRAPHY

Sir Charles Watson's presidential address dealt with two themes—the history of Sudanese geography since Sir S. Baker was the president of the section at the last meeting in Dundee 45 years ago, and the new international map of the world on the uniform scale of 1/1,000,000. His criticisms on the coloring of the map were supported by the section later when Captain E. O. Henrici, R.E., exhibited the sheets as far as they had been published. It was agreed that an uncolored edition ought to be published as well as the "layer" edition now appearing.

The African branch of the president's address was carried further by the papers of Dr. Felix Oswald (from the Victoria Nyanza to the Kisii highlands), Mr. G. W. Grabham (the country north of Lake Albert), and Mr. P. Amaury Talbot (South Nigeria). A valuable paper was contributed by Mr. E. A. Reeves on recent improvements in surveying instruments, and Sir H. G. Fordham illustrated his paper on the Road Books of the United Kingdom by a varied collection of maps and itineraries. Great interest was taken in the Antarctic discussion initiated by Sir Clements Markham, who sketched the history of Antarctic discovery and the outstanding problems. Other speakers felt that in the praise of Captain Scott something less than justice was done to other explorers, and especially to the expeditions which started from Dundee.

Dr. W. S. Bruce in his paper on the Antarctic continent, after reviewing the earlier discoveries, noted that Amundsen had confirmed Shackleton's discovery of the Antarctic plateau, and traced the Victoria land range to the southeast, as well as finally obliterating the suggestion that the Ross Barrier extends across Antarctica, dividing it into two land masses. The biological evidence confirms the evidence of soundings in favor of a former land connection between Africa and Antarctica. Professor Charles Chilton, of New Zealand, took up the biological point, and showed that the inference extended to South America and Australia. Dr. R. N. Rudmose Brown spoke of the structure of the continent, pointing out that the theory of a great strait completely lacked confirmation. Dr. Marshall described the work of Shackleton's expedition, and Dr. Hodgson, of the *Discovery*, defended the use of dogs against the criticisms of Sir Clements Markham. At the very end of the meeting Sir W. Willcocks gave a trenchant and delightfully entertaining lecture on Canadian agriculture and irrigation.

SECTION F—ECONOMIC SCIENCE AND STATISTICS

This was one of the most popular of the sections. All the papers discussed dealt with practical economic issues of the day, and at each meeting the hall was crowded. Sir Henry Cunynghame, of the Home Office, who presided, said at one of the meetings that he was more interested in the establishing of prosperous and contented communities throughout the land than in the discovery of the remains of creatures which existed millions of years ago, and that saying well expresses the spirit of the section.

In his presidential address Sir Henry Cunynghame also pleaded for a thoughtful and rationalist treatment of economic studies. He did not condemn sympathy, for they were all men and could not but be touched by the sufferings of humanity, but they must be practical in their endeavors to find solutions for social evils. An outstanding paper in the section on the first day of the meeting was that of Mr. Herbert Samuel, M.P., the Postmaster-General, who discussed the tendency to find in a federal system of government the varying and sometimes conflicting interests of the different and widely separated communities of the British Empire. There was also a notable discussion on the results of war by Mr. Norman Angell and Archdeacon Cunningham.

Friday was devoted to a discussion of labor problems. The readers of the four papers treated different aspects of the subject. Professor S. J. Chapman presented the general case for and against arbitration and conciliation in the settlement of labor disputes. Sir Francis Webster gave the manufacturers' point of view, noting the causes affecting prices and wages in the last 40 years. Mr. Ramsay MacDonald, M.P., made a reasonable plea for a minimum wage, varying according to locality and industry, giving labor its due share in the profits, but not unfair to the employers. Mr. C. R. Fay considered the limits within which industrial co-partnership might reasonably claim to be a remedy for industrial strife, and described in detail the schemes in operation at Lever Brothers (limited), Port Sunlight, and those in the English gas companies, where the late Sir George Livesey was the pioneer. A letter relating to conciliation

was also read from Sir Charles Macara. Monday's program was more varied. Mr. Allan McNeill discussed the possibility of utilizing national savings for the purchase of agricultural holdings through the machinery of land banks. Miss Annie Ashley instituted a comparison between British and German insurance legislation. Dr. David Heron, in a short address illustrated by lantern slides, gave startling evidence of the failure of inebriates' homes to reform habitual drunkards. Professor Geddes pleaded for the cooperation of the sciences in the town-planning movement and for the preparation of regional and civic surveys for that purpose.

From one point of view the work of the section on its last day was the most interesting of all. The first half of the morning was given to Scottish problems. Mr. James Cunningham, President of the Dundee Chamber of Commerce, gave facts and statistics which are probably not elsewhere procurable, relating to the origin and growth of the jute trade in Dundee and Germany. Mr. Alex. Newlands opened up a fascinating problem—the possibility of developing the water power of the Highlands for industrial purposes. In an impartial paper Mr. J. H. Jones analyzed the effects of dumping on the steel and tin-plate industries, and Mr. A. A. Mitchell closed a most successful meeting with an examination of the question—"Do Trade Unions Raise Wages?"

SECTION G—ENGINEERING

Perhaps the first place among the topics set down for discussion in this section, which was presided over by Mr. Archibald Barr, may be assigned to wireless telegraphy, which has already been referred to under the heading of the section of Mathematics and Physics. A second subject discussed referred to the attempts now being made by workers in different countries to produce a commercial gas turbine. The application of the reciprocating internal combustion engine to the purposes of marine propulsion is regarded as a retrograde step in view of the demonstrated advantages of rotary machinery for such service, and, in spite of the serious difficulties which have to be overcome, it is felt that the efforts being made to construct a commercial gas turbine is a movement along the right lines. A certain measure of success has, indeed, already been achieved, and with so many minds attacking the subject in different ways it is probable that success will be attained at no very distant date. The discussion which was opened by Mr. Dugald Clerk showed what has been done and what has still to be accomplished.

The research on the gas engine itself which is being carried out by the Gaseous Explosions Committee of the British Association is to be continued. The report presented to the present meeting made it clear that useful work is being done by this committee in the settlement of disputed points and in throwing light upon certain questions which have hitherto baffled designers of gas engines. A set of interesting papers on marine problems and developments in marine propulsion opened up a discussion on several matters of current interest. Questions relating to the provision of lifeboats on liners and the special means whereby quick launching may be ensured were the subjects of a paper by Mr. Axel Welin. Another paper showed the real dangers in navigation arising from the suction effect between passing vessels, concerning which there has been a serious conflict of opinion. The case for electrical methods of ship propulsion, which is being closely watched by the British Admiralty, was discussed from the expert standpoint for the benefit of the lay mind.

SECTION H—ANTHROPOLOGY

In the proceedings of Section H (Anthropology) much interest attached to Professor Anthony's exhibit of the cast of the La Quina brain—one of the first examples of a brain of paleolithic man of Neanderthal type to be described and one of the finest yet discovered—as well as to Professor Keith's communication on the Gibraltar brain, which afforded strong corroborative evidence in support of the theories of the evolution of mammalian and especially the human brain elaborated in the president's address. Dr. Duckworth's description of the jaw of paleolithic antiquity found in Kent's Cavern, Torquay, in 1867, but not previously described, which was presented to the section by Professor Boyd Dawkins, was another interesting and important contribution to the study of the antiquity of man—a subject much in evidence at this meeting. Professor Elliot Smith's views on the origin of megalithic monuments, which he associates closely with the beginnings of the use of copper in Egypt, whence he holds the adoption of this form of burial monument spread over the remainder of the world, gave rise to a discussion in which these views were strongly criticized and a number of profoundly interesting questions were raised. The discussion on the ethnological aspects of Scottish folklore, if it did not succeed in elucidating any particular problems

of Scottish ethnology, at any rate brought out the fact that many primitive customs still survive in different parts of the country and will undoubtedly serve to stimulate interest in a subject in which the serious workers are regrettably few. Papers dealing with Egyptian archeology and the ethnology of the Sudan were unusually numerous.

Professor Elliot Smith in his two papers, one dealing with the earliest attempts at mummification in Egypt, and a second dealing with the physical character of the Egyptians of the second and third dynasties, has traced to a higher antiquity than had previously been done the use of this method for preserving the body of the dead, and in the second case has demonstrated the existence of an alien population in Egypt at an earlier date than his previous researches had revealed. Dr. Wood-Jones's paper on the Ancient and Modern Nubas showed that there is evidence of this same process of infiltration of an alien element in Nubia in early Christian times. Mr. Robert Mond's colored illustrations of the Theban tombs excavated by Mr. Gardner were greatly appreciated, both on the ground of their beauty and of their scientific value as accurate records. The papers of Professor Petrie on early dynastic discoveries, and by Mr. Quibell on tombs of the second and third dynasties, both contained important contributions to the study of Egyptian antiquities. To archeologists a melancholy interest attached to Mr. Ogilvie's paper on the Temple of Philæ. The colored slides shown to illustrate the paper were reproductions of recent sketches, and probably will be the last records to be made of the temple, which will be finally submerged in November.

SECTION I—PHYSIOLOGY

Mr. Leonard Hill presided over this section and devoted his address to the important question of ventilation in its relation to health. Some interesting information was given by Professor J. S. Macdonald, who, as a result of calorimetric observations on man, concluded that 25 per cent. of the energy transformed during work is converted into mechanical movement. His experiments were conducted in the large calorimeter at Sheffield University. Dr. A. D. Waller gave an account of the original physiological work done by Patrick Blair about 200 years ago in correctly describing the nerves of the trunk of an elephant which died near Dundee. He dissected the carcass of the animal until, owing to its decomposition, he was compelled to desist. Its bones were subsequently ground to powder and used to fertilize the fields. This section devoted a morning to a discussion on the relation between mind and body—a subject which proved extremely attractive. Another discussion was held in conjunction with the Zoology Section. This had relation to the physiology of marine organisms. Dr. Edridge Green criticized the report of the departmental committee on sight tests. He condemned the wool test as not being efficient in detecting color blindness; and also criticized the form of lantern recommended by the committee, and the method of flicker photometry. Professor Gotch and Professor Sherrington agreed that the wool test was quite inefficient and should not be retained; but they defended the lantern and the form of photometer recommended by the committee.

SECTION K—BOTANY

Two of the most interesting papers in the Botanical Section were read by Dr. C. H. Ostenfeld, of Copenhagen, and by Professor F. E. Weiss, of Manchester. These dealt with the question of hybridism in plants. Dr. Ostenfeld confined his remarks to the genus of hawkweeds (*Hieracium*), one of the most difficult genera with which systematic botanists have to deal, on account of its remarkable polymorphy. As Dr. Ostenfeld showed, some species of *Hieracium* reproduce themselves without fertilization, whilst other species require this; and in a third set of species both modes of reproduction obtain. Crossing species of one of these sets with another, hybrids were obtained; and these first crosses differed remarkably among themselves, thus differing from the first crosses of other genera, which are remarkably uniform. The offspring of the first crosses, however, were quite uniform, thus differing from later crosses of other genera, which are remarkably polymorphous. Dr. Ostenfeld concluded that in this genus of plants new forms have arisen and are arising at the present time (1) by hereditary variation of already existing species, (2) by hybridization and (3) by a combination of these methods. From those forms which reproduce themselves without fertilization very few new forms arise at all; but there are indications even here that new forms arise occasionally by mutation. Dr. Ostenfeld's paper may be regarded as the first step towards a real synthesis of the extremely numerous "species" of the genus *Hieracium*.

Professor Weiss's paper dealt with artificially produced hybrids of two common British species of avens, *Geum rivale* and *G. urbanum*. The first cross agrees with plants named *Geum intermedium*.

Some of the later crosses agree with other hybrid forms described by systematic botanists. It is remarkable that two such well-marked species as the water avens (*G. rivale*) and the wood avens (*G. urbanum*) should produce so many fertile hybrid forms that a very complete series of forms can be obtained connecting the one species with the other. In the discussion which followed it was suggested that the same phenomenon which is happening in *Geum* is happening in the allied blackberries (*Rubus*), a genus as polymorphic as *Hieracium*, except that in *Rubus* there are several (perhaps six or sixty) true species, most of which are hybridizing with one another, and that many of the so-called "species" of *Rubus* are merely hybrid forms corresponding to those artificially produced hybrid forms of *Geum* made by Professor Weiss.

Several papers on ecological botany were read, of which one of the most important was that by Miss Rayner on the Ecology of the Common Heather (*Calluna vulgaris*). The semi-popular address, which was well attended, was delivered by Mr. I. H. Burkill (the newly appointed director of the Botanical Gardens of Singapore) on "The Botanical Results of the Abor Expedition."

The section was well attended, especially by the younger members, and several interesting excursions were made. The visit to Dundee will long be remembered by the members of the section as among the most generally useful and interesting of any meetings of recent years.

SECTION L—EDUCATION

The Education Section marked in various ways an advance upon the time when it was a mere battleground for those who favored this or that method of teaching particular subjects of the school curriculum. The origin of the section was due, in fact, to men who were in the main concerned with the teaching of science. They were not interested in the deeper problems of education; probably, in fact, they would deny that it had any problems other than those which were concerned with how much of the science master the schools ought to tolerate. Obviously, however, if the section was to justify its independent existence, it must take its own line and call to its councils those who make education in the scientific sense of the term their chief concern.

The appointment of Professor Adams as president was in fact a recognition on the part of the council of this claim to independence, and Professor Adams's address on the possibility of an objective standard in education will take rank as a very sane and moderate statement of the present position of the subject as a science. Less directly addressed to the popular mind than is usual, it will be read with marked attention and pleasure by the new school of educational research which is slowly making its way, stimulated perhaps by the influence of the new school of psychology. If it contained no new or startling discovery, the presidential address pegged out the claims, so to speak, upon which education may hope ultimately to take full rank among the sciences.

Closely allied to the presidential pronouncement was the discussion on the psychological processes involved in reading and writing. A report from a research committee presented the latest statement of the results of psychological inquiry, and some admirable papers were read, leading to the general view that much ingenuity is at present misspent in setting up positive hindrances to the rapid acquisition of the art of getting at the meaning of the printed page.

Less technical in its appeal was the discussion on vocational training. Miss Faithfull's was in effect the only dissentient voice in the general call for a curriculum more closely directed to the actual situation of school pupils. There was some little uncertainty about the meaning of the word vocational. Obviously, if a lad is to spend his life in one of the 95 independent operations which enter into the making of a pair of boots, school time would be wasted if its activities were thus confined. The problem of how to give point and meaning to school "lessons" has yet to be solved. It is at least a step forward when the desired end is clearly laid down.

There were interesting discussions on school leaving certificates and the present position of mathematical teaching. Two distinguished physicists, Professor Sylvanus Thompson and Principal E. H. Griffiths, lamented the loss of Euclidean geometry, though there was a general agreement about the value of the work which men like Dr. T. P. Nunn are doing for the humanizing of mathematical studies.

Not the least important of the actual accomplishments of the section was the report on school-books and eyesight. The committee has laid down standards of type, etc., which must profoundly affect the production of school-books and the hygiene of school life. It is much to be hoped that the council of the association will give wide publicity to that report.